

LAND USE INSTITUTIONS IN AN URBANIZING LANDSCAPE

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LAND USE INSTITUTIONS IN AN URBANIZING LANDSCAPE

Development of land use can be controlled through public means such zoning or through private agreements such as property owners' associations, conservation easements and contracts. This dissertation investigates land use institutions in an urbanizing landscape, specifically zoning's impact on land use change and fragmentation, citizen led monitoring of neighborhood zoning violations, alternatives to zoning, and entrepreneurial citizens' development of alternative land use institutions.

In order to assess the impact of land use institutions in an urbanizing environment, I use multiple methods including an institutional analysis that provides the context for understanding the interrelationships between bureaucrats, politicians, and the citizenry. Statistical analyses uncover the relationship between zoning and land cover change and forest fragmentation. A game theoretic study highlights conditions to expect zoning compliance, especially when GIS reduces information costs. An institutional analysis and agent-based model explore the creation of alternative land use institutions.

Five conclusions are derived from this study. First, zoning is driving some conversion of land to urban uses, although this may be due to the types of zoning rules that are adopted. Second, zoning could be used more effectively to reduce forest fragmentation. Third, adoption of online GIS technology could improve zoning enforcement through a reduction in citizen monitoring costs. Fourth, viable alternatives to zoning exist for openspace preservation and cooperative management. Finally, government insensitivity and changing citizen preferences drive the demand for alternative institutions. Land use institutions in urbanizing landscapes can protect community resources, but communities need

to be more conscious about their decisions regarding institution creation, implementation, and enforcement in order to control the urbanizing process and reduce unwanted effects.

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Chapter 1: Land Use Institutions in an Urbanizing Landscape

Uncontrolled urban growth has led to the widespread conversion of rural agricultural and forested land throughout the world. Unchecked growth in the developing world has created problems with basic infrastructure, sanitation, and disease (Ernould, 2000). In the developed world urban sprawl has been linked to dependency on automobiles, habitat destruction and fragmentation, and degradation of air and water quality (Geller, 2003). Biotic homogenization, such as the proliferation of lawns, is a frequent effect of urbanization often leading to species extinction. McKinney (2002) argues that urbanization endangers more species than any other type of land use in the United States.

Development of land use can be controlled through public means such as growth management and zoning or through private agreements such as property owners' associations, conservation easements, and contracts. The most common land use control mechanism in the United States is zoning (Diamond and Noonan, 1996). This dissertation investigates land use institutions in an urbanizing landscape, specifically zoning's impact on land use change and fragmentation, citizen led monitoring of neighborhood zoning violations, alternatives to zoning, and entrepreneurial citizens' development of alternative land use institutions.

Control of urban development is an ever-growing concern for planners, as cities and suburbs expand. Many communities are concerned about protecting natural resources, as well as maintaining vibrancy of existing cities. Urban sprawl is a controversial issue throughout the United States, yet scholars struggle to identify sprawl

beyond a simple measure of population density. In comparison, most people recognize that land surrounding cities is increasingly urbanized, whether suburbs and exurbs are sprawling is a point of contention. Within this dissertation I do not seek to venture into the urban sprawl debate. Instead, I address a number of issues of concern in an urbanizing environment, specifically conversion of land to urban uses, fragmentation, and opportunities for cooperative private land management.

Zoning is one tool used to control the urbanization process in the United States. Today zoning is often used to manage growth as comprehensive land use plans by incorporating growth management strategies in addition to traditional separation of uses zoning ordinances. Within the United States, zoning has been used since the 1920s in more or less successful efforts to control development. Zoning refers to the actual local rules regarding land use, which are applied to particular zones. Comprehensive plans are required to provide long term vision and guidelines for application of the zoning ordinances. Zoning without planning is considered arbitrary (Revell, 1999), but one cannot simply look at the visionary guidelines in planning to understand growth management. Rather zoning's impact should be judged by an investigation of actual land use within jurisdictions, as well as any evaluation of local government's implementation of zoning.

Recently, some states have required growth management controls in local land use plans (Feiock, 1994, Ellickson and Been, 2000) ranging from utility service development fees to growth boundaries. Growth management strategies are varied from market-based strategies to regulatory controls (Feiock, 1994). Zoning is implemented through a comprehensive plan, which may or may not include growth management

strategies. Comprehensive plans are constantly revised as the officials and citizenry change preferences and individual landowners seek variances to their zoning. The ability of zoning laws to control development through comprehensive plans and growth management is not fully understood.

Modern planners seek to use zoning and comprehensive planning to address a wide range of community concerns such as coordination of economic growth. Some planners, however, argue that the minor modifications of most local zoning ordinances are not enough to handle contemporary land use concerns. In 1992, the American Planning Association wrote that "although amended from time to time, the basic legal constructs found in state enabling legislation have changed very little over the past 50 years. . . .As a result, the planning and growth management mechanisms in force in most states in the 1990s are woefully out-of-step with the times" (Diamond and Noonan, 1996). This concern has led many planners to argue for some regional, state, or federal control of planning.

Zoning and planning arose in the early 1900s to prevent problems between conflicting land use and to reduce the mounting nuisance litigation in the United States due to these incompatible uses. Since the 1970s zoning laws have evolved as mechanisms to control and focus development, as well as promote a myriad of community goals from historic preservation to environmental regulation (Diamond and Noonan, 1996). Zoning restricts particular land uses on the parcels included in a particular zoning classification. Historically, planners grouped similar uses together to prevent conflicts, isolating industrial, commercial, and residential ventures. Planning today often attempts to create neighborhoods with compatible mixed uses. This type of

“mixed-use” zoning is more complicated than the original single use zones. It can be difficult to implement, as well as difficult to control.

Planning and zoning regulations may not lead to the intended consequences in one jurisdiction, if its regulations are not consistent with those in neighboring jurisdictions. Of particular concern is *lack* of zoning in neighboring jurisdictions, which may create problems with “leapfrog” development, where development leapfrogs over a jurisdiction with zoning to one without (Carruthers, 2001). Policymakers are increasingly concerned about the effects of zoning laws from neighboring jurisdictions on their county, as well as their county’s rules on others.

Within each jurisdiction, there also may be competing pro and anti-growth policies, such as tax abatements, which encourage economic development, lot size requirements that promote spread, and historic preservation standards, which limit new building. These policies lead to mixed planning results with respect to land use change. Planning has been identified as a potential solution to contemporary environmental issues such as urban sprawl and habitat fragmentation, although frequently there has been mixed results with respect to these goals. Carruthers (2003) identifies inconsistent local land use regulation as a contributing factor to urban sprawl because counties, in most states, are unable to regulate land use in the same manner as incorporated municipalities. Rudel (1989) notes that community characteristics play an important role in their economic development stance. One might expect that urban/suburban municipalities have tighter growth policies limiting development, whereas areas beyond the municipality have limited land use regulations or pro-growth policies, again creating the potential for the leapfrog phenomenon (Carruthers, 2001).

As discussed in *City Limits*, Peterson (1981) argues that cities will compete to limit regulation and taxation in order to attract businesses into the local economy. Thus, I expect that cities competing for economic development will be less likely to enforce or adopt local land use regulations that may be perceived as costly by the business community. More recent research indicates that local politicians may also seek to maintain the community resources, such as parks and aesthetics, in order to attract businesses. Zoning takes away some property rights for landowners, limiting the potential economic gains from the land, so it is often cited as a limit to economic development and growth (Fischel, 1985).

The impetus for this study is the apparent dissatisfaction of planners and communities with traditional zoning coupled with zoning's distinction of being the mostly widely used local land use control. Property rights advocates argue that planners are overstepping zoning's original purpose, as a use of police power to abate nuisances. On the other hand, planners frequently lament that zoning tools are not adequate as a means to create livable communities, which emphasize greenspace, reduce reliance on automobiles, and preserve a sense of place.

Thus, I seek to address several different concerns in this dissertation. The main thrust of the analysis evaluates the relationship of zoning to land use, especially forest use, in an urbanizing landscape. Forest resources are of particular concern for many areas of the country, including southern Indiana, because they provide environmental services, gorgeous views, attract tourists, especially in autumn, and generate significant income from hardwood products.

The second thrust of the dissertation generally investigates zoning's relationship to the community. I explore the mismatches between rules and citizen preferences, especially when this mismatch leads entrepreneurial citizens to create alternative institutions, such as land trusts and property owners' associations. Within the zoning arena, I explore citizens' role as a watchdog for zoning violations, aiding inspector's efforts in zoning enforcement. The majority of the dissertation is focused on zoning, although I explore alternatives in two chapters.

These two main directions fill gaps within the zoning literature by focusing on the impact of zoning in primarily traditional jurisdictions, not innovative cases such as Portland, Oregon. In order to address several issues, I use of alternative methods of analysis, such as computer modeling, as well as use of traditional econometric methods. This dissertation is unique in that it explores traditional zoning rules, in comparison to innovations occurring in progressive states. It is important that researchers address traditional zoning because it is so widely used. Furthermore, I also explore nongovernment alternatives to zoning, which may be better suited than zoning for small scale preservation and land management initiatives.

1.1 Relationship to Literature

Previous studies of zoning have included case studies of individual jurisdictions (for example, Rudel, 1989, Babcock and Siemon, 1985, Babcock, 1966), historical analyses of land use regulation (Diamond and Noonan, 1996, Platt, 1996), analyses of zoning rule implementation (Feiock, 1994, Fleischmann and Pierannunzi, 1990, Ellison, 2001, Thorson, 1997), and studies of zoning's impact on local economies (Fischel, 1985, Thorson, 1997, Fleming, 1999, Hanushek and Quigley, 1990, Harrison, 1977). Recently,

some work has evaluated the relationships between zoning and land cover fragmentation (Brabec and Smith, 2002) or land cover change (Hsieh, et al. 2000, Kline and Alig, 1999). These studies provide valuable information about the impact of zoning on economic development in the abstract or in a particular study area, assessment of the context of rule changes, and describe classic battles between officials and citizens.

Many studies of zoning have focused on “progressive” states such as Florida, Oregon, and Vermont with statewide planning rules and regulations. The statewide efforts have been hailed as means to reduce uncontrolled development (Platt, 1996), yet few studies have evaluated development and land cover change in states with variation in land use controls. As discussed earlier, Indiana is a prime location for an analysis of inconsistent land use controls across counties because some counties do not employ any countywide zoning ordinances (York, 2002, Worgan, et al., 2001). None of these studies have evaluated zoning at the parcel, neighborhood, and county scale.

These multiple methods at multiple scales will allow investigation of zoning from macrolevel regional change at the county level to microbehavior between neighboring landowners. This combination of approaches improves our understanding of the complicated relationships between bureaucracy, citizenry, and politicians at the local level within the land use control arena. General lessons may be learned regarding local governance that could be applied to other municipal problems. Furthermore, this study will help policymakers understand how zoning can impact land use across large areas of land, as well as within a small neighborhood, in order to address concerns about urban sprawl, economic development, and uneven zoning enforcement.

1.2 Overview of Dissertation

My dissertation brings together several studies into a hybrid “book-article” dissertation style. This dissertation focuses on one topic, zoning in an urbanizing landscape, similar to a traditional book style dissertation. The strength of this style of dissertation is that all of the chapters work together to inform a single topic. Yet, the dissertation chapters, especially chapters 3-7, are studies that can stand alone as articles. In fact, versions of five of these chapters are currently under review or forthcoming in journals. This dissertation is also similar to an article format dissertation because earlier versions of chapters 3, 4, and 7 were coauthored. There are several strengths of article dissertation including strong chapters that can be disseminated through journals, use of multiple methods, and ability to collaborate with other scholars. By using a hybrid book-article format, I was able to incorporate the strengths of the two formats in one dissertation. I united strong studies using multiple methods to inform a study of zoning in the urbanizing landscape.

In my dissertation, I first explore the nature of zoning and planning through an institutional analysis, briefly exploring the variation in zoning rules in southern Indiana in Chapter 2, “The Zoning Arena.” Next, I address how zoning impacts county level land use change, through an econometric study of land use change in southern Indiana in Chapter 3, “Regional Impact of Zoning.” This particular issue is important because zoning is often implemented at the county level. Zoning is used to protect open space land cover, so I investigate zoning’s impact open space land cover fragmentation within a county in Chapter 4, “Fragmentation and Zoning in an Urbanizing Area.” Evaluation of zoning’s impact on fragmentation is significant because fragmentation can be an

important indicator of the ability of a landscape to support certain types of species, especially mega fauna (Wang and Moskovits, 2001), as well as the economic value of timber and agricultural production, and perhaps the value of property for residential purposes. The ability of zoning to impact land use is limited by zoning enforcement, so in Chapter 5, “Citizen Reporting and Zoning,” I explore how citizen monitoring may be hampered or helped through recent use of online Geographic Information Systems (GIS) maps by planning departments. Zoning is not the only institutional option for land use management, so I explore other legal mechanisms in Chapter 6, “Alternatives to Zoning: Means to Cooperative Management.” There has been an explosion of growth of one of these alternatives, gated communities, so in Chapter 7 “Growth of Private Governance in the Land Use Arena,” I investigate conditions which may promote this expansion of private sector options. Finally in Chapter 8, “Land Use Institutions: Conclusions and Policy Recommendations,” I explore future directions for research on zoning, as well as policy recommendations stemming from my research.

The study evaluates zoning’s impact on land use at multiple scales using multiple methods. An institutional analysis in Chapter 2 provides the context for understanding the adoption of rules and the interrelationships between bureaucrats, politicians, and the citizenry. This institutional analysis provides context for Chapter 7’s computer model, which highlights conditions when I expect the citizenry to create alternatives to zoning. Statistical analyses aid in understanding the macro relationship between adoption of zoning and land cover change at the county level in Chapter 3. A spatial statistical analysis investigates the relationship between zoning and fragmentation at the parcel level in Chapter 4. The microlevel of individual land use decisions is uncovered with a

game theoretic study of the relationship between neighboring landowners and inspectors in Chapter 5. This game highlights conditions where neighbors will report each others zoning violations, especially when GIS reduces information costs. Institutional analysis is used again in Chapter 6 to investigate alternatives to zoning. A computer model is used in Chapter 7 to investigate microlevel behavior that will lead to growth in private land use regulation. The combination of approaches at multiple scales will allow policymakers to understand the impact of the most widely used land use control mechanism, zoning, on land use.

1.3 Southern Indiana: A Study in Traditional Land Use Policy

In several chapters, I use southern Indiana as a study site, specifically Chapters 2, 3, and 4, although insights from the Indiana case are included in all chapters. Unlike many states, Indiana represents a traditional case for land use policy with limited state involvement, many counties with no zoning, and strong property rights organizations. In Indiana, both counties and municipalities have the authority to zone creating many opportunities for polycentricity at the local level, whereas in many other states only municipalities have the right to zone and plan (Carruthers, 2001). In more progressive states, it is difficult to assess the impact of zoning because of statewide policies, such as Oregon and Vermont, which have centralized planning organizations (Dowall, 1988). Several other states have enacted programs to homogenize planning regimes (Talen and Knaap, 2001). In Indiana, no statewide efforts to create the same types of planning policies have been initiated, so we may expect greater diversity than in many other states. Thus, southern Indiana provides a wonderful natural experiment to investigate the impact of zoning, as well as evaluate opportunities for nongovernment land use policy creation.

Some Indiana counties do not have zoning ordinances, possibly because there is limited growth and development, so there is limited need to coordinate this development. Another reason for the lack of zoning may be that neighboring relationships are well established and Coasian solutions are possible. On the other hand, these rural areas are not as densely populated, so there are fewer people with which to have conflicting uses, which may reduce the need for zoning. Southern Indiana has been chosen as the study site because it has a wide range of zoning and planning regimes, including counties with no planning.

The study also includes a number of rural counties that have experienced population decline over the past decade (Payton, 2001). These varying levels of population growth and declines may lead to different patterns of zoning enforcement and creation, as well as the possibility for alternative land use agreements outside the zoning sphere. Overall, Southern Indiana provides a dynamic and diverse environment for understanding the process of enacting and enforcing local level regulation, as well as the impact of these regulations on land use and land cover change.

1.4 Theoretical Analysis

There are several chapters that focus on a generalized land use policy arena, which is not specific to any particular jurisdiction. These studies enable manipulation of various conditions in games using game theoretic analysis, or exploring parameter values in a computer model. The institutional analyses in Chapters 2 and 6 focus on this generalized policy arena, although insights from empirical research ground the analysis. The theoretical studies allow investigation while controlling for some of the variation found within the empirical studies in Chapters 3 and 4.

The theoretical studies provide insight into the empirical work by allowing for more control of the conditions, such as citizen preference change. This union, the empirical and theoretical, allows for a more comprehensive assessment of zoning and alternative land use institutions. Furthermore, the assessment at several different scales with many methods allows me to address a number of issues that have been overlooked within the literature, especially in traditional land policy areas, such as land cover conversion, fragmentation, zoning compliance, and the growth of alternative institutions.

1.5 Key Issues Addressed in Dissertation

Multiple methods and multiple scales are used to investigate land use institutions in an urbanizing environment. There are almost an infinite array of different issues associated with land use, so I have narrowed this larger investigation into a set of smaller issues that I investigate because they address important policy question that have mostly been overlooked.

First, I address whether zoning protects forestland and farmland. The flip side of this question is whether zoning prevents development, which is a common refrain from communities seeking to prevent zoning adoption because of desires for economic growth, as well as from supporters of stricter zoning controls seeking to protect a community from the perceived ills of further economic development, such as strip malls and loss of forest and farmland.

The second issue I investigate is whether zoning contributes to or prevents fragmentation of forestland. Since large acreages of forestland are desired for wildlife habitat, as well as for economically viable timber harvesting, this question is of concern for many different types of forest stakeholders.

Since zoning mostly controls private landowners' behavior, another issue is whether adopted and implemented institutions match the preferences of landowners, as well as citizens at large in the community. If zoning does not generally match citizen preferences within the community, we expect that there will be difficulty in enforcement and compliance. Thus, addressing the mismatch between zoning and citizen preferences possibly may lead to more compliance and also lead to zoning that better protects forest resources and promotes development, but in less land intensive manners. Since zoning is typically enforced through citizen complaints, another aspect of this dissertation addresses when citizens will report their violating neighbors and when violators will start to comply. This investigation is important because so much zoning literature has focused on the rules, with little emphasis on the implementation and enforcement.

Finally, the dissertation addresses alternatives to zoning or institutions that could be used in conjunction with zoning to protect forestland. To sum up the dissertation, I evaluate how zoning adoption relates to development, whether specific zones correlate with forest fragmentation, when community preferences match zoning rules, the conditions under which reporting will lead to zoning compliance, and evaluate alternatives to zoning.

1.5.1 Does zoning protect forest and farmland?

This dissertation investigates whether zoning protects forest and farmland in southern Indiana. In Chapter 2, we create an econometric model of the land use decision-making process founded on the utility of various types of land uses, which the landowner must evaluate (Plantinga and Buongiorno, 1990, Munroe and York, 2001). With an econometric model I evaluate the influence of demographic characteristics, land

characteristics, i.e. topography, and existence and length of zoning policy enforcement on the land cover change for the 40 sample counties in southern Indiana.

1.5.2 Does zoning lead to fragmentation of land cover?

The second micro level analysis is at the parcel level within Monroe County, Indiana and evaluates the relationship between zoning and fragmentation for selected parcels outside the Bloomington city limits. Landscape fragmentation results from the complex interaction between policy, biophysical characteristics, and socioeconomic development pressure. Because of the negative environmental consequences of habitat fragmentation, policymakers need a reliable measure of the impact of zoning on landscape fragmentation. Given this complexity, it is difficult to determine if zoning regulations have the desired impact on landscape fragmentation.

This research addresses the lack of understating of the impact of zoning regulations on landscape, especially forest, fragmentation. In particular, we try to provide a better understanding of relationships between socioeconomic, locational, and physical characteristics and measures of landscape pattern that occur at the scale of individual parcels of land.

1.5.3 When do we expect zoning compliance?

In Chapter 5, I use a game theoretic analysis to understand the conditions by which a citizen will report neighboring violators. I explore how the emerging use of Geographic Information Systems technology may alter this game with the increasing ease of online information gathering. Written zoning rules are only as effective as the actual rules that are enforced. One of the primary mechanisms through which enforcement occurs is via neighbor complaints. The game models a common problem in the zoning

arena. Inspectors have limited resources and are unable to canvas an entire county. Violations can be difficult to spot from afar. Certain types of violations may only be visible during a short period of time. Therefore, like many police measures, zoning relies on citizen complaints to be enforced.

1.5.4 What are the alternatives to zoning?

I highlight strengths and weaknesses of zoning in the first five chapters of the dissertation. In the Chapter 6, I explore the alternatives to zoning, especially with regard to cooperative forest management. There are several existing legal mechanisms that can be used to manage private land use, such as conservancy districts, property owners' associations, contracts, and easements. In this chapter, I use institutional analysis to explore the strengths and weaknesses of each approach. I compare these approaches with traditional zoning.

As discussed earlier, in Chapter 7, I explore the mismatch between citizen preferences and government provision of zoning. This chapter also explores the role of entrepreneurial citizens in the creation of new institutions, such as land trusts or gated communities. This theoretical computer analysis highlights conditions in the local policy arena that will lead to more innovation and nongovernment institutional creation. These two chapters aid in our understanding of institutions that could be used in conjunction with zoning, as well as institutions that could replace some of zoning's functions.

1.6 Union of Approaches

Overall, the combination of the approaches will aid in our understanding of land use regulation creation, enforcement, and impact on the landscape. Urban development

in rural areas is a topic of increasing concern. Land use planning seeks to reduce incompatible neighboring uses. The onslaught of criticism of zoning and requests to do away with traditional zoning create a need to better understand zoning's impact on land use. Before, we take away power from local governments to control land use through regional or statewide regulatory bodies, first we must understand how that land use control mechanism is working within its current context, especially in traditional land use policy regions. In order to best assess the impact of zoning, I incorporate multiple scales to understand the institution of zoning in the southern Indiana context, at the county and individual landowner levels, as well as evaluate the institution in the abstract with insights from empirical literature.

In this dissertation, I assess the ability of zoning to impact land use change. I evaluate the strengths and limitations of a local self-governance approach to land use regulation through a multiple scale and multiple method approach. Policy makers need to address the effectiveness of the most common United States land use control, zoning, to deal with land use and land cover change.

In the United States, the population pressure in combination with changing preferences has caused urban sprawl through the conversion of farm and forestland to residential and commercial uses. Communities frequently seek to control this process of land use change through a number of policies, including zoning and planning, ecosystem management plans, forestry policy, and private agreements. This study of local land use regulations at multiple scales addresses the future viability of zoning policy within the United States. Most importantly this study will evaluate the microlevel processes that lead to macrolevel land use and cover change. Previous studies have evaluated zoning as

an independent variable in land cover change models or as a tool towards visionary planning goals. Preliminary evaluation indicates that zoning is a part of a simultaneous relationship with land use and land cover change. To understand the impact of a self-governing local land use regulatory regime, one must study the institution and the land use and land cover change simultaneously. In the concluding chapter, I discuss how this combination of approaches could aid in future policy analysis of land use policy and policy-making in general. Overall, this study will provide useful information for modelers of land use, planning practitioners, and local citizenry, as well as the developing community seeking to evaluate a self-governing land use regulatory regime (Hanushek and Quigley, 1990).

Chapter 2: The Zoning Arena

Local level zoning and planning policies reflect the diversity of communities populating the American landscape. Some scholars insist that American communities have limited or even no land policy. “Writing about the land policy of the United States is a trifle presumptuous. There is no de jure land policy (Dowall, 1988: 153).” There is no one land use policy in the United States. Rather, land use policy is created from a polycentric government, including local zoning and planning, as well as state and federal incentive and regulatory programs. Within jurisdictions there is a wide range of goals and objectives in comprehensive plans and many means to achieve the land use goals through zoning ordinances.

In this chapter, I explore the zoning policy arena generally through institutional analysis. Then, I explore how zoning may be impacted by community characteristics. I then investigate the similarities and differences in the Southern Indiana comprehensive plans. This exploration will help in the understanding of how these policies impact the landscape.

Zoning in the U.S. is created through local government units that are enabled by state legislation. Zoning is the result of a myriad of local level interactions including public hearings, elections, conversations, and court proceedings where citizens, developers, officials, bureaucrats, and judges take action. In the next section I explore the nature of the goods associated with land and how these goods are connected to zoning and planning. I describe the major actors and their interactions in the local zoning and planning arena. This institutional analysis will utilize the Institutional Analysis and

Development (IAD) framework, which explicitly delineates actors, rules, institutions, and hierarchy.

2.1 Nature of the Good

Markets produce many different types of goods, but there is often under provision of public goods. In the US, the government is able to provide many public goods such as protection from internal and external threats, regulation of markets, and creation of infrastructure, which are not adequately produced by the market. Social scientists have created a typology to categorize the different types of goods. Economists have distinguished public and private goods on two axes, excludability and rivalrous nature. Four different categories have been outlined along these two axes, pure private good, pure public goods, toll good, and common pool resources. How does land fit into this classification scheme?

Excludability		
	Non-Rivalrous	Rivalrous
Excludability	Toll Good	Pure Private
Non-Excludability	Pure Public	Common Pool Resource

Figure 2.1. Typology of Goods¹

¹ Adapted from Figure 5.2. A Classification of Goods: Private and Public.

The study of land use regulation must begin with the question, “What is land?” Land, the good, is very complicated; it is an input in production functions, a place to recreate, a location for environmental services, a home, and many other goods. Land values are linked to location, nearby employment opportunities, accessibility to markets, cultural opportunities, as well as the activities of nearby neighbors. For example, does the parcel of land in question exist near a market for produce, or a city with demand for residential units and employment opportunities? Historically, access to roads, rivers, trains, and canals critical for the development of a city and region, and also impacted the value of land that was near these transportation modes (Judd and Swanstrom, 2004). Accessibility is still important in the determination of land prices, although a moderate level of inaccessibility may not decrease the value of natural resource reach areas.

One land use, a residence, may on the surface appear to be a single private good, but we can further break that down and see that goods stemming from residential land use potential include: a place to build a house, gain shelter from storms, have a home business, and perhaps grow produce in a garden. “‘Housing’ is one of many commodities which, like ‘food,’ are not homogenous goods, but combinations of separate and diverse items. Except that they are bought and sold together as parts of a single bundle, these items may have no resemblance and nothing in common (King, 1973: 5).” If we extend this analogy to a parcel of land, we see that parcels differ on a variety of quality vectors each may be seen as a good of some sort.

Land has many different attributes and should be considered the origin of many different uses and goods. Some of these uses generate income for the owners, whereas non-financial uses include recreation and shelter. Neighbors may derive additional

benefits from the beauty of certain types of land cover such as fields or forests on adjacent land, whereas some uses may generate unwanted smells and noises, or unsightly waste that results in a negative externality.

Land is both a private and public good because of its many uses and values. The local community may benefit from a landowner's forest because of the aesthetics, while the global community benefits from carbon sequestration, two public goods from a private land use. The individual landowner will benefit from the timber in the forest, a private good. Land regulation therefore, must take into account the heterogeneous nature of land use and value, as well as the public and private attributes of land uses.

Zoning restricts the ability to use land in particular ways. One common type of land use restriction prevents landowners from raising livestock in urban areas, thus preventing unwelcome noise and smells. This restriction generates a public good, the abatement of negative noise and smell externalities. The externalities should be placed in the public good category or "public bad" category in Figure 2.1. The benefactors for each type of land use regulation may be local or global. For instance, the increased concern about protecting greenspace in and around urban areas has beneficiaries who enjoy the beauty, as well as beneficiaries from the protection of habitat for threatened or endangered species.

Zoning also has another type of benefit for landowners; it can stabilize property values within an area. This stabilization perhaps could be viewed as a public good that strengthens the property rights to a private good, the house located on the land. In a sense, zoning could be seen as increasing tenure for accepted uses, such as residential, while decreasing property rights for potential incompatible uses.

Another type of public good associated with land is open space in parks, forests, and agricultural land. Within a jurisdiction, a landowner may decide to develop a parcel, while neighbors may prefer that the land is preserved as open space. This conflict sometimes crosses jurisdictions, as one community may prefer to develop a piece of land, which neighboring jurisdictions would prefer it preserved (Platt, 1996). Government provision of public space may be necessary if it is ever to be provided because of the general problem of excludability, inability of landowners to force benefactors to pay for open space. Some open space may be provided by entrepreneurial landowners that fence off recreational open spaces and charge an entry fee. The problem of underprovision is exacerbated by the inability of a jurisdiction to exclude residents from neighboring towns from utilizing a park without paying taxes for it. Park provision and planning for open spaces affects the value of land within a jurisdiction, so there is some incentive to create parks that increase the wealth of taxpayers in the district.

Some zoning policies attempt to preserve privately held open space through zones for agricultural production and forest use. These zones may have minimum lot size restrictions and also restrict other uses on property. It can be difficult to use zoning to protect private space, especially if the local government is concerned about lawsuits from developers. As developers acquire open space, they may be willing to go through extended legal battles in order to develop it. Some local governments may be unwilling to pay for the legal fees.

Some argue that the government should not regulate land use because the private market could create Coasian solutions to land use externalities. The land use externality was one of the original justifications for use of local police powers for land use regulation

(Diamond and Noonan, 1996). Private contracts or agreements do occur, especially in rural areas where the conflict involves parties that are well acquainted (perhaps related) to one another. A farmer-developer may approach individuals within a community and try to establish an agreement without outside litigation or legislation (Rudel, 1989). Oftentimes, the transaction costs of these Coasian solutions are prohibitive and the property rights to land use are not well defined, which limits the general applicability of this type of solution. If agreements are not attained or maintained the parties may seek litigators to help solve the problem. Legal nuisance suits were the main, and only formal, solution to land use problems prior to zoning and planning. The limitations of private agreements and litigation led to more proactive land use regulations. Typically, zoning is the most frequently used land use regulation tool in the US (Platt, 1996) and is primarily used to prevent externalities stemming from conflicting uses on nearby parcels, i.e. adjoining residential and heavy industrial uses. Planning is an overarching tool used in conjunction with zoning to establish long-term goals and visions for land use in the community.

Recently, planning and zoning has been identified as a potential solution, as well as a potential challenge, to urban sprawl and habitat fragmentation. Carruthers (2001) identifies inconsistent local land use regulations as a contributing factor to urban sprawl because counties, in most states, are unable to regulate land use in the same manner as incorporated municipalities. Since zoning in unincorporated areas is often less restrictive than zoning within adjacent municipalities, developers “leapfrog” to the unincorporated areas with fewer regulations (Carruthers 2003). Carruthers (2003) has found that this leapfrog phenomenon contributes to sprawl through inconsistency in zoning.

In Indiana, counties are enabled as land use regulatory bodies, so differences between county and city planning may have more to do with political orientation of the overall jurisdictions, which Rudel found in other exurban areas (Rudel, 1989). Therefore, one might expect that urban/suburban municipalities have tighter growth policies limited development, whereas areas beyond the municipality have limited land use regulations or pro-growth policies, again creating the potential for the leapfrog phenomenon described by Carruthers (2001).

The planning community recently has identified principles that enable communities to grow, but in a manner that is “smart,” typically referred to as “Smart Growth” principles (Talen, 2001). Smart Growth principles include: compact urban form, maximizing existing infrastructure, walkable communities, and quality of life (Talen, 2001), principles that are supposed to allow a community to develop in a way that limits negative environmental impacts and promotes a community’s sense of place, its individuality. The planning community’s support for Smart Growth is not always mirrored within the community. Planners may find it difficult to realize Smart Growth principles in typical Indiana communities that prefer single family homes to multifamily housing (Worgan et al. 2001). A community’s political orientation and culture is an important component in the effectiveness of zoning to achieve particular principles, such as Smart Growth.

2.2 Zoning

Zoning enables the government to separate incompatible uses and may minimize the volume of nuisance litigation. Zoning may be considered a “good” in its own right in the sense that zoning laws are a public good that an entire community benefits from and

must be sustained through community monies and effort. In this study, I am mostly focusing on the impact of zoning. Zoning creates a set of limited property rights for particular parcels, but these rights often are not transferable (Nelson, 1980). The property rights are non-transferable and may be changed, so zoning protect the value of other bundles of goods such as houses. For example, a commercial use such as dry cleaner that was grandfathered in as an accepted use within a residential zone would not necessarily be permitted to continue legally if the property was sold. Zoning could be viewed as a collective property right of the local government serving the collective well-being through the abatement of nuisance suits.

The need for zoning may have increased with urban growth, which has lead to an increased number of landowners with incompatible uses. In Bloomington, Ind. urban sprawl is hot topic of debate, polarizing citizens throughout the community. Some argue that economic growth in the urban-rural fringe is beneficial and increases job opportunities. Others state that the strip malls, apartment complexes, and sub-divisions are only degrading the rural character of the region. The value of land is tied up in its potential use, so zoning, by controlling the potential usage, also limits the value of the parcel.

The stabilization of property values is seen as a huge benefit for certain groups, such as homeowners. Through zoning ordinances, these homeowners may fail to realize higher benefits from alternative uses, but their property will not lose value from neighbors using their land for factories, for example. Some have argued that zoning won acceptance throughout the US because it strengthened property rights, especially for homeowners, through the prevention of nuisances (Babcock, 1966). The establishment of

zoning gave jurisdictions the power to prevent some nuisance suits through the establishment of usage zones. This generally held up the property values of certain areas, protecting the rights of some established owners. Property owners that had planned to develop their property in a manner that was inconsistent with the usage zones sometimes faced great losses in potential income because the policies prevented the most profitable usage of the land. This increased opportunity costs was typically borne by individuals that planned on developing their land for uses besides single family residential, such as manufacturing, retail, or even multi-family residential (Fischel, 1985).

Hamilton (1978) argues that zoning is a monopoly power through the assertion of homeowners' collective property rights. The monopoly power of the local government, often controlled by residential interests (Babcock, 1966, Babcock and Siemon, 1985), restricts the designation of zoning for nonresidential uses. This monopoly power is especially important, because land use designation will impact the land's market value, and the assignment could also be viewed as distributive policy. Landowners that are able to attain a rezoning for commercial or retail are able to reap substantial benefits via increased land prices in a predominately residential area. Similarly Babcock and Siemon (1985) note significant increases in land prices in Florida markets after a landowner is able to obtain a rezoning for residential development, especially in jurisdictions attempting to restrict growth. Local governments have great control over who receives the economic benefits of rezoning.

Zoning as distributive policy has also been a controversial class and racial conflict. In the *Mount Laurel v. NAACP* case the crux of the argument against the city of Mount Laurel was its denial of low-income housing. The NAACP brought a suit against

the township of Mount Laurel alleging discriminatory land use regulatory practices, which were keeping low income and minorities out (Hughes and Vandoren, 1990). The *NAACP v. Mount Laurel* case illustrates the opportunity of nonlandowners to voice their opinion about the activities of the government through the judicial system. The conflict between homeowners and potential apartment or condominium dwellers and developers is frequent in many municipalities.

One of the justifications for zoning and planning in early court cases was its ability to prevent nuisance litigation through the separation of incompatible uses (Revell, 1999). Today zoning is sometimes used as a mechanism to control and focus development, as well as prevent conflict between incompatible uses (Rudel, 1989, Talen, 2001). Within each jurisdiction, there also may be competing pro and anti-growth policies, such as tax abatements to promote development, lot size requirements to maintain a rural character, and historic preservation standards, which lead to mixed planning results with respect to land use change. These competing demands and preferences for land use within the community set up strategic games between interest groups, such as environmental, development, and residential groups. Strategic interactions also occur among the elected officials, planners, and citizenry, especially in the plan development and enforcement stages. Furthermore, there may be strategic games between jurisdictions who perceive themselves as in competition for firms that could aid economic growth.

Planning and zoning goals may not lead to the intended consequences as many of the regulations are not consistent with neighboring jurisdictions. Carruthers (2003) identifies inconsistent local land use regulation as a contributing factor to urban sprawl

because counties, in most states, are unable to regulate land use in the same manner as incorporated municipalities. Rudel (1989) notes that community characteristics impact the local government unit's stance towards economic development. One might expect that urban/suburban municipalities have tighter growth policies limiting development, whereas areas beyond the municipality have limited land use regulations or pro-growth policies, again creating the potential for the leapfrog phenomenon (Carruthers, 2001). Therefore, this chapter will also include a brief account of general community characteristics that may affect the development games. The ability of communities to regulate growth is complicated by the difficulty in assessing and containing sprawl.

2.3 Action Arena

The action arena is where rules are made, enforced, and broken (Ostrom, 1999). The local zoning and planning action arena consists of public hearings, government meetings, as well as some behind-closed-doors bureaucratic planning meetings. The actors in this arena compete for passage of comprehensive plans that capture their preferences, for examples standards and goals for aesthetics, public parks, public health, segregation of incompatible uses, and freedom to utilize private land. Some groups such as developers may be more active in the land use regulation arena, but it is difficult for any one group to control the policymaking arena because of the complex hierarchy (Figure 2.2).

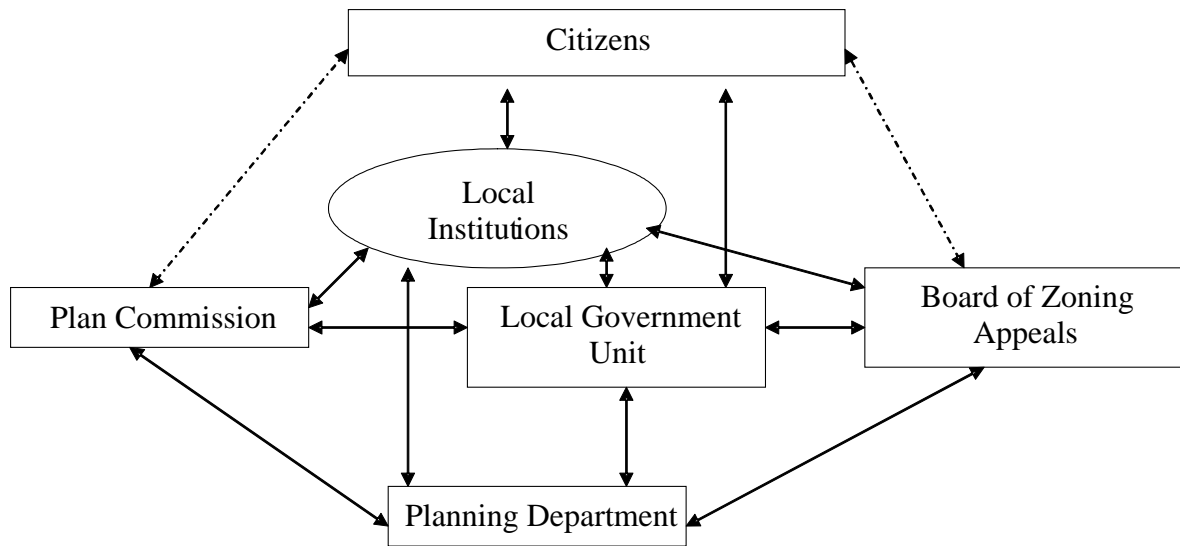


Figure 2.2. The Zoning and Planning Action Arena

The actors in the community may change over time due to increased residential or industrial growth, which causes changes in community preferences. Thus the action arena is dynamic across time with changing relationships amongst actors. In the next section, I will outline the main actors in the local land use regulation arena.

2.3.1 Actors

The actors in the action arena represent diverse interests and positions with elected officials in the local government unit, the plan commission members, professional planners, zoning inspectors, board of zoning appeals, and citizens routinely involved with land use regulation policymaking. The state legislature and the judicial system support the local arena through state enabling legislation and judicial decisions on land use cases.

These actors' preferences and experiences may differ from place to place, but there are some general characteristics that will be discussed in the following sections.

2.3.1.1 Local Government Unit

The local government unit may be a township, town, village, city, or county depending on the enabling legislation of the state. The local government unit is made up of elected citizens that vote on zoning ordinances and plan amendments. The local government unit may also appoint members of the plan commission and board of zoning appeals. Depending on the community characteristics, the local government unit may also hire a planning consultant or staff planner because of potential pressure from their constituents, or government officials own preferences for land regulation. Citizens are able to express their land use preferences through the electoral process, as well as through letters, phone calls, and public hearings. The government unit passes and amends the ordinances and plans, which the Plan Commission initially recommends. Frequently, neighboring jurisdictions form Area Plan Commissions, which coordinate planning. These area commissions may complement or supplant the work of the local Plan Commission.

2.3.1.2 Plan Commission

The Plan Commission members are appointed by the local government unit. These members are citizens of the community with varying experiences in land use planning. The plan commission makes recommendations for rezoning after a public hearing, but the elected government unit has the final authority to rezone the land in most jurisdictions (Fleischmann and Pierannunzi, 1990). The composition of interests within the commission varies with the community type. Sometimes, there may be a

disproportionate representation of development or conservation interests. For example, the planning commission members may be a part of the established development community in urban areas because regular citizens have limited information about the complex regulations, as well as limited personal benefit from changes to regulations, whereas developers may sustain substantial financial gains through policy changes in urban areas. The planning commission is responsible for making recommendations to the local government unit regarding the comprehensive plan and any amendments to the plan.

Typically, citizen preferences reach the plan commission through public hearings and personal relationships with commission members, or concerns expressed indirectly through the local government unit and the electoral process (Figure 2.2). Since the planning commission is not directly accountable to the public, there may be coordination problems between the constituents and the plan commission recommendations. Some local governments have created a forum for additional meetings in order to facilitate communication with the citizenry (Department of Metropolitan Development and Division of Planning, 1991). The plan commission frequently works with a number of other local government units and related commissions, such as an environmental commission or the parks and recreation board, which may further complicate the policymaking process.

2.3.1.3 Professional Planners

The plan commission, or the local government unit, often hires a planning consultant or staff planner(s) to direct their planning activities. Rudel indicates that planners may have extensive education about land use law and visionary planning goals,

but not about the conditions in which various regulations should be applied (Rudel, 1989). The planner may be idealistic and have environmental or social goals that are incompatible with the nature of the community. "We begin with the dismal fact that the planner, whether consultant or staff member, finds that he must spend more time working with zoning than with any other planning tool; zoning, the very device he has been taught in planning schools and professional conventions to regard as a dull, ineffective tool (Babcock, 1966)." The professional planners have different education and possibly different personal preferences with respect to land use than the rest of the community. These preferences may have caused the planners to enter the planning profession, or were shaped during their acculturation into the planning community. Thus, there seems to be inherent conflict between the planning department employees and the elected and appointed officials.

This inherent conflict between the officials and the planners may be exacerbated in smaller communities where a consultant planner is employed because the community is not large enough to afford or warrant a full-time planner. The consultant planner most likely has other projects in other communities. Therefore, each community may receive a cookie-cutter plan established from previous projects. Consultant behavior may be restricted by a desire for good recommendations from the community, but the consultant's income is not as closely related to the community's satisfaction as the income of a staff planner. The outside consultant may also have more limited knowledge of the local area than a staff planner who probably lives in the area. Thus, it may be difficult for the community to obtain a plan incorporating their preferences with a consulting planner.

Even with staff planners, there are coordination problems with the Plan Commission and the local government unit. The planners may receive directions from multiple political perspectives that are difficult to coordinate within a single plan. Babcock (1966) found in the 1960s that planners were disturbed by the political conflict between the plan commission members and the elected officials. This type of conflict between commission members and elected officials seems to be common because planners cite ability to foster compromise amongst stakeholders as a valuable skill in creation of comprehensive plans (Ellickson and Been, 2000). There are multiple sources of coordination problems with the planners because citizens, plan commission members, and government officials frequently have limited technical and legal knowledge of planning (Figure 2.2). The limited technical information available to officials and citizens, or the limited information that is understandable to these layperson groups, lead to classic information asymmetries and managerial dilemmas (Miller, 1990). Planners sometimes only interact with citizens through formal hearings (Figure 2.2). By the time citizens interact with the planners at the public hearings the decision-making is usually in the hands of the government unit and the plan commission. Thus, we may expect that it is difficult for a plan to match community preferences due to the lack of interaction between citizens and planners and the difficulty for officials to access the technical plans.

2.3.1.4 Zoning Inspectors

Inspectors are required to enforce the comprehensive plan, but typically do not have the resources to effectively police the entire jurisdiction. Given the scarce resources, inspections often come as a result of citizen complaints, so compliance success is often related to neighborly policing and issues of citizen concern. These problems are

further complicated by the limited and spotty enforcement of zoning ordinances (Ellickson and Been, 2000). Ellickson and Been (2000) note that inspection is often left to building departments who may not have sufficient knowledge of zoning ordinances, which leads to a principal-agent problem between the building department inspectors and the planning department. This problem is exacerbated by limited planning department control over building inspectors' work assignments and job performance rating. Another potential issue with zoning inspection is that the comprehensive plan may have development goals that are not expressed in actual enforceable zoning ordinances due to the inability to create regulations with specific, legal language and standards that fully incorporate lofty, visionary goals of the comprehensive plans. Plans are only as good as the supporting ordinances, which in turn are only partially enforced by the inspectors².

2.3.1.5 Board of Zoning Appeals

After zoning decisions or violations are given to citizens, they may appeal to the Board of Zoning Appeals (BZA), which is appointed by the local government. The BZA often deals with the hardship variance cases, where BZA must determine whether the citizen has suffered undue hardship because of the zoning. The BZA's authority is fairly limited with respect to granting variances (Ellickson and Been, 2000). The board also frequently handles grievances from the building permitting process, so BZA resources are stretched between the planning and building arenas (Ellickson and Been, 2000). Like the planning commission, the BZA may or may not reflect the distribution of community preferences. Therefore, there may be coordination problems between the citizens of the community and the decisions of the board. Citizens mostly influence the board indirectly

² The plan language may also serve to signal a change in preferences, for example an increased environmental concern, which may deter development or promote growth. The plan language also may raise awareness within the community about the loss of greenspace or the need for industrial development.

through elections of the government unit, or informally in conversation (Figure 1). If the landowner or citizens are unhappy with the BZA decision they may appeal to the justice system.

2.3.1.6 Citizens

Citizens represent a diverse group in the development arena, including landowners and neighbors, and sometimes developers. Citizens may appeal decisions in the comprehensive plan first to the BZA and then to the justice system. Citizens may express their opinions at the public hearings for proposal and adoption of the comprehensive plan, amendments, and zoning appeals. Finally, citizens may express their views through the electoral process and informally by talking with the elected and appointed officials. Citizens frequently protest development at public rezoning hearings, but organization of an opposition force represents a collective action problem. Some citizens may not want the development, but will free ride on the efforts of their neighbors.

2.3.1.7 Justice System

The justice system handles appeals after board of zoning appeals decisions. The courts power to invalidate zoning regulations is mostly limited to a test to whether they are arbitrary and capricious (Babcock, 1966). The court does investigate appeals on an individual basis, but the burden of proof is placed upon the citizen or landowner to prove that the comprehensive plan or amendment was unjust. Since the trials are conducted on the basis of expert testimony, they are often prohibitively expensive and are frequently avoided through the Board of Zoning appeals process. As will be described in the games section, the justice system is an essential component of the land use regulatory process.

Without the justice system, there would be no higher power to aid in sanctioning noncomplying uses, as well as no outside referee for the highly political comprehensive planning process.

2.3.1.8 State Legislatures and Congress

State Legislatures and the U.S. Congress have enacted many land use regulations including local zoning enabling acts. The state enabling acts represented a constitutional rule change that allowed local governments to control some private land uses. Both Oregon and Vermont have enacted state-wide planning commissions that direct some local land use regulation. "The Oregon legislature has attempted to support agriculture by minimizing instability for commercial farms. It has done so in many ways, but the most important step was requiring all cities to adopt urban growth boundaries (UGBs) and prohibiting counties from approving urban-scale development outside them (Diamond and Noonan, 1996)." State legislatures and Congress typically are involved only in enabling acts, except in Oregon and Vermont where the state legislatures are involved with specific land use legislation. Congress has also passed legislation that impacts land use such as Clean Water Act, especially Section 404 that deals with wetlands, and the Endangered Species Act.

2.3.1.9 Other Actors

There are many other actors in the local land use regulation arena including: lawyers, local government bureaucracy, developers, and non-governmental organizations. Lawyers often serve as consultants for local government units, citizens, and landowners in zoning appeals, but lawyers are not always part of the process. Like planners, lawyers have specific technical knowledge, which leads to coordination and monitoring problems

because citizens, local government officials, and landowners may have limited legal knowledge. Finally, nongovernmental organizations are significant actors in local land use in many communities. These organizations may express preferences for limited urban sprawl or increased economic growth.

2.3.2 Community Types

The variation among state land use legislation enabling acts is echoed in their application to different community types within each state. These differences reflect the local community characteristics. Urban and rural residents have different expectations about economic growth and different preferences for land use. Hogs may be a nuisance in New York, but the rule in Iowa. A strip mall may signal a new economic awakening to rural residents, but exurbanites may view the mall as damaging their country view. In this section, the differences in land use regulation in various community types, city, suburbs, urban-rural fringe, and rural, will be discussed.

2.3.2.1 City

The city is often populated by a diverse community with a wide array of preferences. The connection between the citizen and the government officials may be weak. In comparison to smaller communities, few citizens know government officials personally, leading to coordination problems between the constituency and officials. Even with a large scale urban bureaucracy and distant elected body, some citizens have pressed officials to pass interesting land use legislation, which that meets their unique needs. The Soho artists restricted entry to their neighborhood in 1971 by persuading “the New York City government to establish an Artists Certification Committee that would certify applicants as professional artists and then to make such a certification a zoning

requirement for SoHo residency (Nelson, 1980)." The Soho Artist Certification process is a unique variant of land use regulation, but often urban residents are frustrated and confused by the land use policy making process. Within city government, there is also a problem of coordination between city departments. The number of actors in the urban local land use arena is probably quite large, which may lead to elite actors, such as developers or wealthy commercial interests, controlling land use discussion. "In some cases, boom-and-bust examples abound within one metropolitan area, leading to conflicting or contradictory policies, given the absence of local government coordination (Dowall, 1988)." Dowall's discussion illustrates the problem of inconsistent land use policy in urban areas, but this problem is also found in other community types.

2.3.2.2 Suburbs

In comparison to urban areas, the suburban land use debate was largely controlled by residential interests until quite recently. Suburban residents often protect their quality of life and property values by establishing lot size restrictions. The 1926 Supreme Court ruling in *Euclid v. Ambler Realty* voiced the widespread belief that "that an apartment house in a low-density neighborhood was 'a mere parasite, constructed in order to take advantage of open spaces and attractive surroundings created by the residential character of the district' (Hallett, 1988)." Suburban land use is often chiefly residential with some commercial use districts, particularly for service industries. In comparison to city residents, suburban residents are frequently more motivated and informed about local land use regulation (Rudel, 1989; Ellickson and Been, 2000). Citizens and landowners may be more involved in the action arena balancing the power of other elite groups, like developers. In a sense, the suburban homeowners are the elite group in the suburbs.

They are often able to prevent the movement of poorer residents into the area through limitations of low-income housing, although the language of these comprehensive plans and zoning ordinances typically utilize vague language to avoid discrimination suits like *NAACP v. Mt. Laurel* (Hughes and Vandoren, 1990). Recently some suburban areas have focused on inclusion of commercial and retail land uses in residential areas, especially through the New Urbanism design movement (Judd and Swanstrom, 2004), although many suburban areas still focus on residential interests.

2.3.2.3 Urban-Rural Fringe

The urban-rural fringe is distinct from the suburbs because it is populated with exurbanite residents and rural natives, creating a unique conflict in the action arena. "For exurbanites, most of whom do not rely on land for their income, the countryside is first of all a park, a place valued largely for its amenities. . . Only the creation of publicly approved constraints on individual land users, usually in the form of zoning laws, can assure the preservation of the park-like atmosphere (Nelson, 1980)." The exurbanite residents often rely on neighboring urban or suburban communities for employment, so may not be sympathetic to some rural residents' use of land for income. Typically, there is a gradual shift from rural to urban-rural as through the development of agricultural land into single-family subdivisions, as the rural shifts to suburban there often is a shift toward more restrictive land-use controls (Rudel, 1989). The urban-rural fringe often has an emerging developer interest and strong exurbanite interests.

2.3.2.4 Rural

In comparison, rural communities often experience limited economic development. Rural residents may not expect a small development project to lead to

extensive development. "Because rural populations are relatively immobile, neighboring landowners have often known one another for long periods of time, and the nature of this relationship can affect the way a neighbor reacts to a proposal to develop the land (Rudel, 1989)." In rural areas, neighbors are often able to work out land use concerns without interference from the government. Large development plans may actually lead to the initial zoning ordinances in rural communities. Thus, the rural government unit could be characterized as reactive, rather than proactive in land use regulation.

In rural communities, personal relations with government officials and neighbors are the norm. Rudel describes a typical situation where plan commissioners talk before a meeting and the chairperson, a banker, mentions a meeting with developers who applied for a loan during the past week and "that he considered them to be 'responsible' developers whose application should be approved. The pro-developer bias illustrated here appears common among land-use authorities in former farming communities (Rudel, 1989)." Former farming, and other resource-dependent, communities may evaluate development as a positive move toward economic growth in a relatively depressed farming area.

2.3.3 Games

Within the land use arena as described in Figure 2.2, there are strategic interactions between actors. The outcomes of these games may depend on the type of community where the game is played. Most communities feature competing interests such as farmers and exurbanites, or low-income apartment developers and homeowners, although the relative strength of these interest groups may vary depending on whether the community is on the urban-rural fringe or in a suburban area. These competing interests

create several games in the land use regulation arena. For all of the games the actors may attempt to change the forum in order to have the best chance to obtain their desired result, for instance obtain a rezoning or variance. The participants may attempt to forum shop in order to make the process easier (The Harvard Law Review, 1990). In order to do this, developers in particular may decide to pursue a development in a more lenient zoning jurisdiction (Babcock and Siemon, 1985).

One general type of game is the social dilemma where participants (citizens) need to contribute towards a public good. In the land use regulatory arena, there are several social dilemmas such as creation of greenspace through the regulation of private property or abatement of traffic congestion through a denial for a commercial rezoning. Citizens benefit from the public good, the aesthetics and carbon sequestration from greenspace or the limited traffic, but individual property owners bear the burden for these public goods. Thus policymakers need to strike a balance between the maintenance of greenspace or the promotion of economic development and the citizen's interests. One type of social dilemma that is common in policymaking is the collective action problem (Rudel, 1989). Several common games will be outlined below that are general social dilemmas. There is also discussion of a contracting game that is one strategy to cope with the uncertain zoning approval process.

2.3.3.1 Creation of a Comprehensive Plan

The process of creating a comprehensive plan involves many different, competing stakeholders, including the plan commission, professional planners, citizens, and auxiliary committees. As can be seen in Figure 2.2, a basic map of the stakeholders is already quite complicated. The citizens represent a diverse group including the

landowners, developers, and the neighbors. They indirectly influence the creation of the plan through public hearings, but do not have decisionmaking authority except through their elected officials. Likewise, the plan commission members and planners can make recommendations, but the final vote is usually with the local government. This already complex arena has additional complexity when one includes the various committees that inform planning activities, such as the historic preservation, parks and recreation, utilities, and environmental committee.

In construction of the comprehensive plan, sometimes the plan commission has a specific proposed development in mind. In many small, rural jurisdictions comprehensive planning arises in response to large new developments (Olson, 1965). Rudel (1989) recognizes that increased development may lead to land use regulation, but only indirectly links developers' influence to local land use decisions. In other areas, there may be sweeping changes to a plan, when a large development is proposed in order to prevent the intrusion³. Creation of land use regulations in the face of impending development is often the most controversial and litigious land use policy because these rules could be construed as arbitrary and capricious due to the fact that they were made in relation to one project.

The comprehensive plan may include a variety of supplementary documents and tools. In Bloomington, Ind. there is a Growth Plan, which focuses on maintaining greenspace, coordinating infrastructure development, and reducing urban sprawl (Babcock and Siemon, 1985). The Growth Plan also includes some historic preservation elements, such as architecture guidelines for historic buildings, which lead to heated

³ This occurred in Tuxedo, New York, which declared a building moratorium in order to review existing zoning ordinances when faced with a large development proposal

debate (City of Bloomington Planning Department, 2002). Recently, one Bloomington, Ind. landowner tore down several older homes that were scheduled for historic listing (Denny, 2002). As might be expected, landowners may try to preemptively act by destroying a building or changing a land use before the regulation can affect their use rights. Overall, there is a lot of strategic action involved in plan construction, as the plan will alter affected landowner's property values and rights.

2.3.3.2 Enforcement of a Plan

A comprehensive plan and associated regulations are only as good as the monitoring and sanctioning associated with it. If residents do not witness credible land use policing, we may expect that there will be widespread noncompliance. Many jurisdictions do not have the resources to effectively monitoring land use regulations violations. Throughout the country, governments rely on citizen complaints to enforce the zoning ordinances (Ellickson and Been, 2000). Therefore, land use regulatory enforcement probably will be concentrated in the most visible types of violations. The problem with citizen enforcement is that it only works if citizens are willing to take the time to generally be aware of legal uses under the zoning ordinances, to watch their fellow citizens' use, and report the offense. Thus, many citizens are willing to free-ride on others policing, so there is the typical collective action problem associated with citizen lead enforcement. Figure 2.3 illustrates the informal connection between landowners and inspectors.

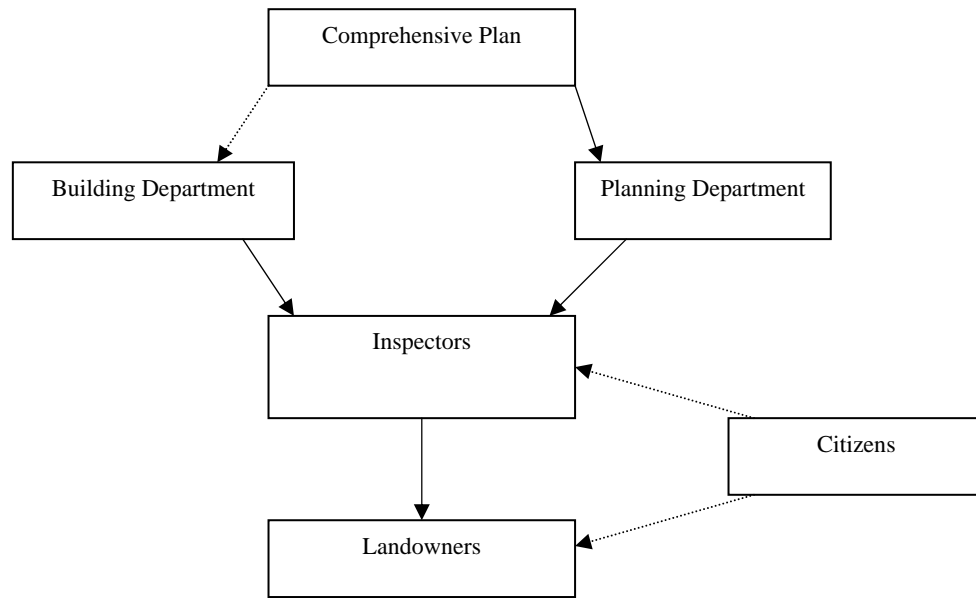


Figure 2.3. Enforcement of Comprehensive Plan

As mentioned earlier the *de jure* ordinances may or may not effectively advance the goals of comprehensive plan due to the “legalese” used in ordinance construction. The difference between the plan goals and the actual regulatory goals is one potential source of the ineffectiveness of land use regulation. Irregardless of whether the ordinances reflect the plan, the basic ordinances frequently are not upheld because of the lack of monitoring resources.

Another enforcement problem is that inspectors may be building inspectors who are asked to enforce land use regulation ordinances without sufficient training. Similarly, these building inspectors’ job security is tied to their enforcement of the building code, so we may expect that there is limited incentive for the inspectors to enforce the zoning codes, another principal-agent problem. Since, there are repeated interactions between

the planning department, building department, and inspectors, the principal-agent problem may be overcome as reputations are established and trust builds between the two departments (Johnson, 2001). Then planning department and plan commission may increase their ability to direct the inspectors' actions by establishing good relationships with the building department.

Professional zoning inspectors under the direction of the planning department may know and understand the zoning laws, but have their own priorities with respect to enforcement (Figure 2.3). In a conversation with a southern Indiana zoning inspector, he indicated that each inspector has a priority, such as run-off control or elimination of junk cars on front lawns. These priorities focus the inspectors' activities, but not all plan components and zoning ordinances may be a priority. Therefore, if non-conforming landowners recognize that no one cares about compliance with a particular ordinance, the owner probably will continue the illegal use with limited fear of getting caught or fined.

In some jurisdictions there have been instances where noncompliance has led to costly fines or injunctions, where the landowner was required to tear down a building or to remodel it to fit the zoning ordinance. In one case in New York, an apartment developer was required to remove twelve stories of thirty-one story complex to conform to the ordinance, at an expense of \$2 million (Ellickson and Been, 2000). As mentioned earlier, variances are sometimes granted for landowners that experience a hardship due to the regulation, although frequently self-created hardships are exempt qualify for a variance (Ensminger, 2001). In order for land use regulation to be effective the *de jure* rules must match the *de facto*. There must be a credible threat of enforcement of the rules in order for the land use regulation to be effective.

2.3.3.3 Property Sale for Development

The first game in the development process is the sale of land to the developer. In many cases, vacant land is owned by a farmer, especially along the urban-rural fringe. This farmer/landowner may evaluate the feasibility of continued production on the land, prior to sale, but may be unaware of the technicalities of the development process, or the development potential of his land. After the developer approaches the landowner about developing the land, the landowner's awareness of the investment quality of the land has increased and he may begin a development project on his own.

Frequently, obtaining permits for development is a complex and risky process, so the landowner will enter into a contract game with the developer due to the difficulty of obtaining rezoning and variance approval. Of course, there are information asymmetries between each party. The landowner may be more aware of the community characteristics, and whether there will be opposition to the development. On the other side, the developer probably has more extensive knowledge about the legal and business aspects of development.

One common type of sale arising from this contracting game is the conditional sale, where the landowner receives a deposit with the rest due upon rezoning approval, or building permit approval (Ellickson and Been, 2000). The landowner receives a higher payment because he shares the risk of approval with the developer. It is easy to see why such a contract would evolve out of this game, as there are information asymmetries amongst the parties, and the permitting process is typically risky. Another interesting aspect about the conditional contract is that it creates an alliance between the developer and landowner, which may help in the permitting process. If the landowner has been a

longtime resident his fellow citizenry on the plan commission and in the local government unit may trust his judgment and proposal more than if a developer came in by himself with no ties to the community.

2.3.3.4 *Opposition Coordination*

In the process to rezone the property, the developer needs to notify the planning department that she is proposing a rezone. Then the public is notified of the public hearing for the rezoning. There is the collective action game amongst the neighboring landowners. The landowners, and possibly other environmental or residential advocacy groups, may organize to protest the rezone.

Babcock and Siemon describe a case in Palm Beach, Florida, where wealthy residents sought to prevent multi-family condominium development. This particular case was interesting as many of the opponents were new Palm Beach apartment and condominium residents whose buildings had “slipped in before the Town could change rules (Ellickson and Been, 2000).” Frequently, the opposition to development is a diverse coalition of homeowners, environmentalists, and competitors (Babcock and Siemon, 1985).

In many communities, environmental concerns are a rallying point for opposition coalition formation. In Bloomington, Indiana, environmental groups tried to prevent the commercial development of an apartment development in a karst area and were able to gain support from nearby landowners (Ellickson and Been, 2000)⁴. Similarly in Sea Ranch, Calif., Babcock and Siemon (1985) describe a heated controversy over environmental protection of the coastline and a group of landowners with clearance for

⁴ Karst is a type of broken limestone terrain characterized by caves and underground streams that is prone to sinkholes Isaacs, Alan, John Daintith, and Elizabeth Martin (eds.) 1999. *Oxford Dictionary of Science*. New York: Oxford University Press.

construction. There are many different motives for the anti-development contingency in rezoning cases, although frequently the opposition is made up of residents seeking to maintain their property value. Similar to the collective action problem with citizen enforcement of zoning, opposition formation and protest of rezoning proposals creates a free-riding problem. Each individual opposing citizen would be happiest with the defeat of the proposal without having to attend meetings or expend time or effort in the process⁵.

2.3.3.5 Rezoning strategy

The rezoning game is a complicated, risky multi-step game. The proposal comes before the governing body with the plan commission's recommendation. The developer and neighbors are allowed to voice their viewpoints at the plan commission and government unit hearings. The game is quite complicated with the governing officials balancing political considerations with the merits of the individual rezoning proposal. The officials need to think about the public's reaction to their decision, especially if it is a high-profile rezone and they hope to retain their seat at the next election. The officials may also have some interest in preventing the developer from creating a new apartment complex or commercial development, especially if the official is a competitor. Many of the plan commission members have outside commercial or political connections to land use policy, and frequently are real estate agents, land use lawyers, environmental activists, and developers. Some of the members may have a decidedly pro-growth stance considering their occupations. Other members may need to make recommendations about a competitor's or client's proposal. Recently, in Bloomington, Ind. a county commissioner, a lawyer, had to make a recommendation about a former client's proposal

⁵ There may be a few citizens that enjoy the fight or have political ambitions who may actually get utility out of the zoning game.

for a rural single-family home development (Hinnefeld, 2002). The citizenry that make up the vocal opposition to developments often include neighbors, environmental NGOs, and competitors (Ellickson and Been, 2000). Therefore, we can see that there are several different types of games occurring simultaneously within the rezoning process with actors making strategic moves that take into account the community's well-being, the comprehensive plan, and more selfish, personal economic motives.

One study found that the “best predictor of a local governing body’s decision in a rezoning case is the recommendation of the appointed planning commission (Van der Dussen, 2003).” Interestingly, Fleischmann and Pierannunzi found that the plan commission’s denial recommendations for rezoning proposals were more consistently ratified by the local government boards in Illinois than commission’s recommendations for approval (1990). Perhaps, this illustrates that during the rezoning approval process the local government body faces more intense political pressure than the plan commission members and professional planners who are not elected, thus possibly creating a higher threshold for plan approval. Babcock (1965) found that the professional planners, plan commission members, and government officials often had very different opinions with respect to development approval. In a famous case in Tuxedo, New York, Babcock and Siemon (1985) spoke with an official who stated he was not going to vote for rezoning approval for a multi-family development because of political pressure, even though he conceded that it may be the “right” thing for the community’s economic development.

In some jurisdictions the approval process is so risky that developers have created a niche market for rezoned land. The developers buy land zoned for less profitable use and take it through the approval process to rezone it multi-family or single-family

residential, for example. Then they resell the property to a builder at a premium. These developers establish strong political connections to plan commission members and elected officials in order to reduce the rezoning risk, and in some markets they receive substantial profits selling rezoned land (Ellickson and Been, 2000). These market incentives lead to problems of collusion and suspicion with regard to campaign financing. In Monroe County, Ind. there were concerns about conflict of interest when a decisive rezoning vote was cast by a county commissioner who was the former lawyer for the development proposal (Fleischmann and Pierannunzi, 1990). The developers' ability to establish a good relationship with the Plan Commission and local officials may directly correlate into rezoning success. Likewise, if a developer violates zoning ordinances officials may reject rezoning proposals in the future due to liability concerns.

2.3.3.6 Litigation

At all points in the planning process, both sides need to make a credible threat of litigation. Without this crux either side will not have the bargaining power to make the hard choices during the development and enforcement process. In Babcock and Siemon (1985), there is a description of many notable court cases where the battles were very heated probably because of the high court expense and long periods of time involved with litigation. These court cases represent a wide range issues, ranging from discriminatory land use regulation to environmental protection through regulation, but all illustrate similar final step in the land use policy arena. If any of the games fail, the players end up in court, if both are willing to make the sacrifices. After the court battle, judges may send the players back to the local authority and to the bargaining table, thus they reenter some of the games described above. The threat of litigation is essential in order to force the

actors to “hold up their end of the bargain” whether in the compliance with zoning ordinances or in the “legal” creation of the comprehensive plan. Therefore, litigation serves as an essential and often overlooked part of the zoning and planning arena, which must be utilized in order to effectively implement planning policies like control of urban sprawl.

2.4 Planning in Southern Indiana

Indiana experiences all the problems described earlier with zoning enforcement, plan creation, and mobilization of interest groups. Indiana has many counties and municipalities that are representatives of the community types described in the previous sections, although rural and rural-urban fringe community types predominate in spatial area. I evaluated the comprehensive plan documents for southern Indiana in order to assess their relationship to basic principles of Smart Growth, the new type of planning recommended by the American Planning Association (Talen, 2001). This is especially important in order to explain future chapters that assess the impact of these institutions on land use and land cover change and fragmentation.

The basic principles were modified from those used by the Center for Urban Policy and the Environment in their investigation of central Indiana planning. I included citizen participation, government collaboration, and zoning enforcement, in order assess ability of communities to achieve the principles. The principles were gathered from 25 county plans in southern Indiana, three plans were unavailable.

Principles	Identifier used	n	%age
Planning for growth	References to population growth/loss	16	64%
Livable built environment	Pedestrian uses; compatibility of uses	14	56%
Responsible regionalism	Competitive advantage; economic development; promotion of region	14	56%
Harmony with Nature	Preservation natural resources and/or agricultural land	13	52%
Plan and fund infrastructure	Use of a capital improvements plan	13	52%
Compact urban form	Infill development in areas with infrastructure in place	10	40%
Variety of choice in housing	Affordable housing; advocating different types of housing	10	40%
Quality of life	References to parks, open space, sense of identity; sense of community	9	36%
Maximizing infrastructure	Using infrastructure that already exists	9	36%
Equity	Affordable housing; impact fees	8	32%
Balance of multi-modal transportation system	Public transit and/or alternative forms of transportation like greenways, bike paths, and pedestrian walkways or sidewalks	8	32%
Government collaboration	Reference to need for current of future government collaboration	8	32%
Infrastructure development	Impact fees or requirements that developers pay	7	28%
Place-based environment	Preservation of natural resources or agriculture; energy conservation	6	24%
Historic preservation	References to preserving historic structures or districts	6	24%
Citizen participation	Means to encourage citizen participation	6	24%
Costs of implementation	Identification of how costs of plan recommendations will be paid for, strategies for securing funds	5	20%
Improving development review processes	Allowing more ease for implementation and permitting flexibility	4	16%
Reasonable, predictable, fair plan review processes	More predictable review process for both developers and public interests	4	16%
Zoning enforcement	Mention of need to enforce existing or new codes	4	16%
Mixed-use, walkable neighborhoods	Sidewalks and development with different types of uses; receptiveness to mixed use	3	12%
Implementation responsibility	Identification of person or agency responsible for plan implementation	2	8%
Implementation schedule	Time-line for implementation of plan recommendations	1	4%
Assessment of progress	Identification of methods for measurement of plan's success	1	4%

Table 2.1. Comprehensive Plan Principles in Southern Indiana

As can be seen in Table 2.1, planning and dealing with growth is the most common Smart Growth principle that these plans addressed. The majority of plans also addressed a livable built environment and responsible regionalism. Responsible regionalism usually was discussed in the plan as positioning the community for economic development. Whereas, the livable built environment was typically addressed through discussion of zoning for compatible uses. Harmony with nature and planning and funding infrastructure were also discussed in the majority of plans. Harmony with nature usually meant a focus on agricultural preservation programs or goals. Communities often discussed planning for infrastructure, but only two counties addressed funding for the infrastructure. The weakest principles for these counties were implementation and assessment. Only one county included quantifiable measures for assessment of plan progress. Similarly, only one county included an implementation schedule, although the schedule focused primarily on infrastructure.

Thus, we see that counties in this study area include many Smart Growth principles in their plans, although the counties do not focus on the implementation and funding for these initiatives. There are many areas that these communities could improve in their plans in order to better reduce urban sprawl and grow in a smart manner, according to the Smart Growth principles identified by the American Planning Association (Talen, 2001). The majority of counties were concerned about the protection of their rural and agricultural resources, but were also concerned about economic development. Thus, planning potential could help to aim development toward resource poor areas, while protecting important natural resources. This brief analysis of principles illustrates that the plan for this area are quite varied.

As discussed in previous sections, the ability of communities to achieve plan goals is difficult as actors must navigate the complex action arena. Once a plan is in place the limited enforcement of the plan and indiscriminate granting of variances reduces the effectiveness of the plan to achieve its goals. Now that we have explored the general zoning arena and the zoning policies in place in southern Indiana, in the next chapter I move into an analysis of regional analysis of zoning's impact on land use. Specifically the next chapter evaluates zoning's impact on the decision to use land for forest, agriculture, or urban purposes. As noted earlier, many of these counties are seeking to preserve agricultural land, so the next chapter addresses whether adoption of zoning, over no county-wide zoning, is positively or negatively related to agricultural, forest, and urban land uses. Since there are few implementation strategies or funding initiatives for many of the Smart Growth principles, in reality most zoning in southern Indiana is fairly traditional and focused mostly on separation of uses. Thus, a simple study of zoning versus no zoning will give us a rough assessment of zoning's impact and will provide direction for future research.

Chapter 3: Zoning's Impact on Forests, Farms and Strip Malls

The previous chapter explored the zoning policy arena and described conflicts that characterize the arena. In this chapter, we explore how zoning and tax policy impacts land cover change in southern Indiana. As indicated in the previous chapter, forestland and farmland are often targets for protection in southern Indiana. Southern Indiana is an urbanizing environment, although the pressure varies throughout our study area. The following study presents evidence of how zoning impacts land use development and protects natural resources.

By Abigail M. York and Darla K. Munroe¹

3.1 Introduction

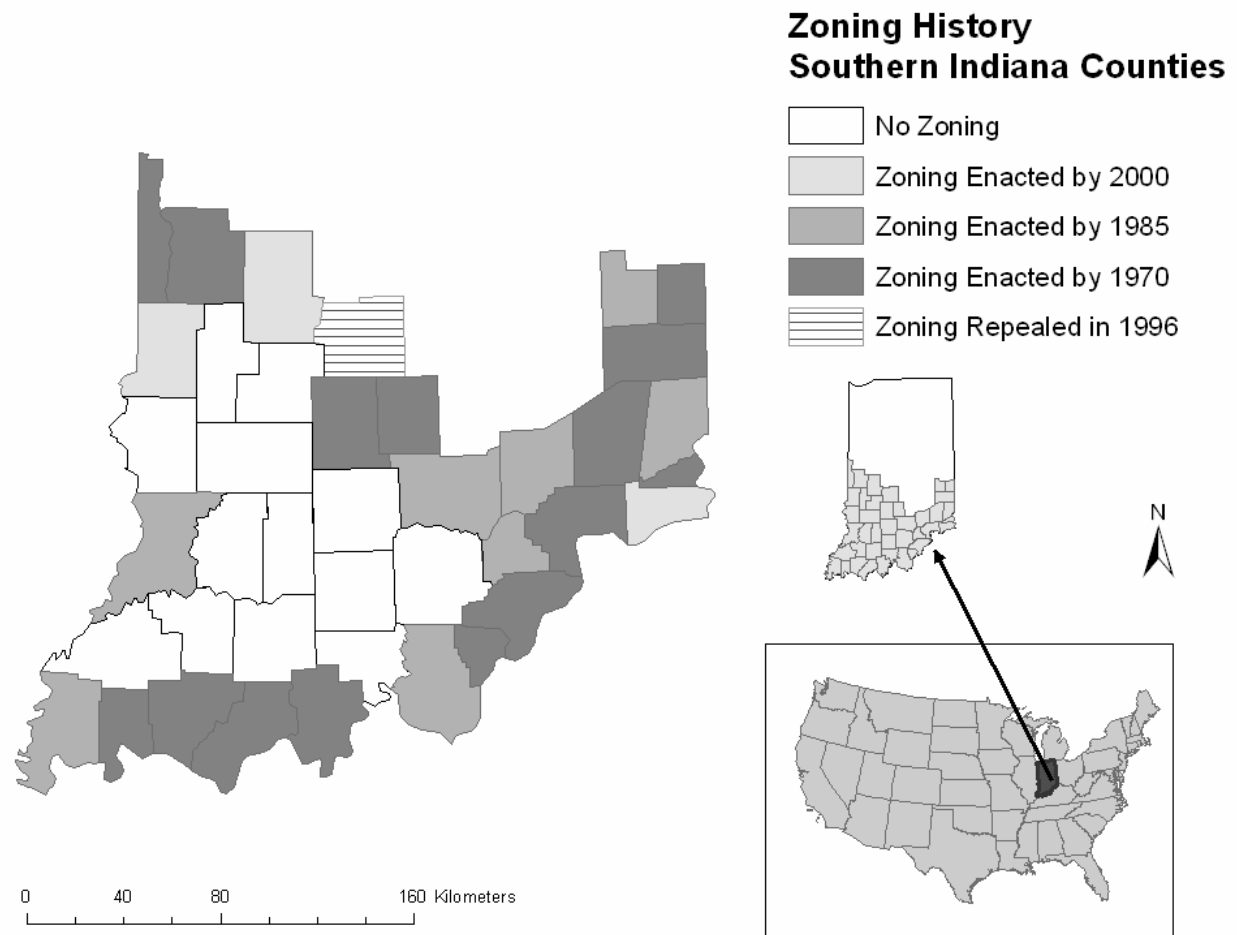
Increasingly, threatened forestland and farmland is a topic of concern for communities throughout the United States. Subdivisions, strip malls, and office complexes spring up amid cornfields and trees in peri-urban areas. In order to control urban sprawl and protect forest and agricultural space, many communities and states have adopted growth management policies. Progressive cities, such as Portland, Oregon, use urban growth boundaries to stifle sprawl, but progressive growth controls are the exception, not the rule. Frequently, county or city zoning ordinances are the primary growth management controls. The ability of these local zoning ordinances to protect open spaces and control urban growth is not fully understood, although several scholars have characterized local level zoning as ineffective in the absence of a comprehensive regional approach (Carruthers, 2003, Diamond and Noonan, 1996, Dowall, 1988, Platt,

¹ This chapter is a manuscript under review with the *Land Use Policy*, "Zoning's Impact on Forests, Farms, and Strip Malls: An Investigation of Southern Indiana Counties," by Abigail M. York and Darla K. Munroe. There is an added introduction and conclusion to connect the article to the rest of the dissertation.

1996). Prior analyses have focused on zoning's impact on forest and farmland conversion in isolated plots, parcels, or cities (Brabec and Smith, 2002, Kline and Alig, 1999, Stone, 2004). Thus most analyses investigate specific zoning policies, but do not assess the broader impact of zoning on land-use conversion in a regional context. We seek to evaluate the impact of county level zoning on farmland, forestland, and urban uses across the southern Indiana region.

Southern Indiana presents a unique study area in that it has experienced significant forest regrowth on private land during recent decades, has varying levels of zoning ordinance adoption, and varying levels of population pressure. Many counties in southern Indiana do not currently have zoning ordinances, or enacted them only in the past five years. Unlike some states, Indiana has not passed legislation requiring county level zoning, as can be seen in Figure 3.1. Thus southern Indiana provides an ideal location to evaluate the impact of county level zoning on urban, forest, and agricultural land use. Moreover, comparing the extent of urban development across counties with divergent experiences in the implementation of growth management policies can be of great use to policy makers. Similar to many regions throughout the United States, southern Indiana is increasingly experiencing urbanization in peri-urban areas (Erickson, 2002, Deller, 2001, Phillips, 1993). Southern Indiana's hills, forests, and agricultural scenery attract residents seeking rural amenities. Our research focuses on the effects of local land use controls in the context of these regional and countywide trends of urbanization. Our study is an extension of earlier work (Munroe and York, 2003) that evaluated the impact of changes in regional economic employment patterns on county level land use and reforestation trends.

Figure 3.1. Zoning in Southern Indiana



This study investigates the joint impact of land use policy and a broader set of economic and institutional determinants on land use patterns at the county level over the past three decades, from 1970 to 2000. The 40 county study area includes three United States Forest Service (USFS) forestry units that have similar ecological and topographic features, hilly land and relatively poor soils, which were not glaciated by the Wisconsin glacier² (Figure 3.1). The 40 counties provide great variation in the issues of concern,

² This 40 county study area stands in stark contrast to the flat, glaciated areas of Northern Indiana, which have extremely good soils for crop production.

including zoning policy, as can be seen in Figure 3.1, as well as population pressure, economic structure, and tax rates. In the following sections we discuss the importance of nonindustrial private forests, discuss the theoretical foundation for the model, construct the econometric model, provide results, and conclude with discussion and directions for future research.

3.2 Nonindustrial Private Forestry in Indiana

This study focuses on nonindustrial private forests (NIPFs), as well as agricultural and urban land uses. NIPF land use is of particular importance because NIPF lands make up the vast majority of forest in Indiana. These forests provide valuable timber, especially hardwoods such as oak and walnut, as well as ecological services, recreation opportunities, and aesthetic benefits. We evaluate whether zoning protects NIPFs, as well as how larger regional economic trends impact NIPF extent. NIPFs are particularly important in Indiana, but are also of great importance throughout the United States where in 2001 NIPFs constituted over 474 million acres, almost two-thirds of the all forestland (Hibbard, et al., 2003). In some regions, NIPFs are the primary source for wood products such as, pulp, lumber, plywood, and other wood productions (Rickenbach, 2002). The National Research Council Committee on Prospects and Opportunities for Sustainable Management of America's Nonfederal Forests found that "NIPFs also provide a wealth of nontimber benefits that extend from tangible benefits of clean water, wildlife, and biodiversity to less tangible but equally valuable benefits of recreational enjoyment, scenic beauty, and cultural ideas of place (National Research Council, 1998)." In many areas throughout the United States there has been an increase in the extent and age of the

forests since World War II (Birch, 1996), but how is this reforestation impacted by local land use controls?

Within Indiana there have been both afforestation and deforestation trends, as can be seen in Table 3.1, from 1968 to 1998 counties in Indiana have both gained and lost NIPF land. Some counties experienced regrowth in the first period, 1968 to 1986, whereas others gained in second. In Figure 3.1, existence of zoning ordinances at the county level can be seen. Two of the five counties, highlighted in Table 3.1, that have gained forest cover over the 1968 to 1998 period, Crawford and Sullivan County, do not have county level zoning controls. Three counties, Franklin, Perry, and Union County, gained forest cover and have had zoning controls at the county level since at least 1970. In our study we attempt to evaluate afforestation and deforestation trends that are due to agricultural abandonment and residential development, while accounting for institutional impacts from zoning and taxation. Thus, we seek to uncover the complicated relationship between zoning and forest cover, as well as other important local economic and demographic variables that will help us understand NIPF regrowth and decline. The econometric analysis allows us to evaluate the impact of zoning on NIPF, relative to other uses.

Table 3.1. Trends in Area of Forest Cover on Private Land, Thousand Acres

County	1967 1,000 Acres	1986 1,000 Acres	1998 1,000 Acres	Percent Change 1967-86	Percent Change 1986-98	Percent Change 1967-98
Brown	68.73	76.2	64.71	11%	-15%	-6%
Clark	78.53	59.9	65.81	-24%	10%	-16%
Clay	71.31	35.3	36.69	-50%	4%	-49%
Crawford	89.15	96.2	97.14	8%	1%	9%
Daviess	34.65	38.0	21.95	10%	-42%	-37%
Dearborn	102.18	105.4	83.41	3%	-21%	-18%
Dubois	61.2	58.8	51.29	-4%	-13%	-16%
Fayette	37.98	30.9	21.75	-19%	-30%	-43%
Floyd	35.59	28.5	23.38	-20%	-18%	-34%
Franklin	101.66	91.2	107.68	-10%	18%	6%
Gibson	38.32	27.2	28.64	-29%	5%	-25%
Greene	127.51	118.4	100.21	-7%	-15%	-21%
Harrison	96.68	102.3	89.44	6%	-13%	-7%
Jackson	86.86	85.4	69.31	-2%	-19%	-20%
Jefferson	104.01	84.3	80.14	-19%	-5%	-23%
Jennings	63.38	64.6	48.16	2%	-25%	-24%
Knox	59.52	31.4	17.73	-47%	-44%	-70%
Lawrence	125.6	96.9	98.63	-23%	2%	-21%
Martin	57.63	57.2	54.75	-1%	-4%	-5%
Monroe	112.22	78.7	86.24	-30%	10%	-23%
Morgan	86.11	67.9	63.76	-21%	-6%	-26%
Ohio	31.56	22.3	18.64	-29%	-16%	-41%
Orange	95.3	76.9	91.5	-19%	19%	-4%
Owen	97.88	92.3	87.42	-6%	-5%	-11%
Parke	88.75	79.8	75.61	-10%	-5%	-15%
Perry	83.09	88.6	89.11	7%	1%	7%
Pike	26.49	35.1	24.12	32%	-31%	-9%
Posey	42.77	40.2	42.59	-6%	6%	0%
Putnam	101.6	77.0	76.69	-24%	0%	-25%
Ripley	63.04	61.7	60.88	-2%	-1%	-3%
Scott	34.18	42.4	30.47	24%	-28%	-11%
Spencer	74.62	57.0	50.13	-24%	-12%	-33%
Sullivan	31.59	38.7	37.09	22%	-4%	17%
Switzerland	92.5	59.7	80.22	-35%	34%	-13%
Union	12.65	14.9	13.49	18%	-9%	7%
Vanderburgh	34.57	15.9	6.31	-54%	-60%	-82%
Vermillion	36.85	27.1	27.75	-26%	2%	-25%
Vigo	69.54	42.1	42.07	-39%	0%	-40%
Warrick	62.23	63.9	48.47	3%	-24%	-22%
Washington	108.65	111.4	107.95	3%	-3%	-1%

Counties with forest regrowth from 1968 to 1986 are highlighted.

3.3 Theoretical Foundation

The theoretical foundation of our model was developed in Parks and Murray (1994) and Ahn et al. (2000) who postulate that land-use shares at the county level are the collective result of underlying benefit-maximizing behavior of landowners over an infinite time horizon. Land use profitability, or the expected return from all possible land uses, is influenced by market accessibility, soil fertility, topography, and other factors. Land use change occurs when there are significant changes in prices, economic conditions, policies, or infrastructure development. Changes in zoning policies represent changes in the institutions, the formal and informal rules (Ostrom, 1999), that govern landowner behavior through incentives and disincentives. In our previous study (Munroe and York, 2003), we found that, in addition to variations in topography and soil quality, regional economic structure was an important determinant of county-level land use patterns. In this study we explicitly account for local policies such as zoning and tax rates, along with economic structure and physical landscape characteristics.

We assume that observed land use at the county level is a function of unobserved net benefits to those uses (Ahn, et al., 2000, Parks and Murray, 1994, Plantinga and Buongiorno, 1990, Plantinga, et al., 1999). A price-taking risk neutral landowner will maximize his/her discounted expected net returns by allocating portions of his/her land to different activities, such as agriculture, forest, or development. The landowner attempts to maximize the net present value of an infinite stream of returns from the prospective land use, or mixture of land uses, without loss of generality. Thus, the shares of land use

are modeled as a function of the benefits to be gained from forest, agricultural, and developed land uses given the institutional constraints in each county.

The expected shares of land use, derived from the aggregation of individual decision-making at the county level, are represented as a logistic function linear in the decision variables, X , and the unknown parameters, β_k :

$$p_k(t, i) = \frac{e^{\beta_k X(i, t)}}{\sum_{k=1}^3 e^{\beta_k X(i, t)}}, \quad (3.1)$$

where p_k is the probability that land use k is chosen relative to an exhaustive set of possible uses: agriculture, forest, and urban; for individual i at time t . Within each county land was assigned to three categories: forest (private, non-industrial forest area), agriculture, and urban/residual. The last class is defined as the total land area minus land devoted to agriculture and forestry, less water and public land. In each time period, the total shares of land sum to 1. We iteratively compared each land use to the other two possible categories via the semi-log formulation:

$$\ln\left(\frac{y_k(t, i)}{y_1(t, i)}\right) = \beta_k X(t, i) - \beta_1 X(t, i) + \varepsilon_k, \quad (3.2)$$

where y_k is the area in land use k , y_1 is the base land use for comparison, and ε is the error term. This model is identified if we constrain β_1 to equal zero (Ahn, et al., 2000). The ratios of agriculture to forest, urban to forest, and agricultural to urban, thus represent the trade-offs between these uses as a dependent variable. This framework is useful in the

identification of the relative effect of land use profitability and suitability on the observed shares of land use (Mauldin, et al., 1999).

Equation (3.2) can be expressed as:

$$\begin{aligned}\ln(y_{ag}/y_{for}) &= \beta_{agf0} + \beta_{agf1}X_{1it} + \beta_{agf2}X_{2it} + \dots + \varepsilon_{it} \\ \ln(y_{urb}/y_{for}) &= \beta_{urbf0} + \beta_{urbf1}X_{1it} + \beta_{urbf2}X_{2it} + \dots + \varepsilon_{it} \\ \ln(y_{urb}/y_{ag}) &= \beta_{urba0} + \beta_{urba1}X_{1it} + \beta_{urba2}X_{2it} + \dots + \varepsilon_{it}\end{aligned}, \quad (3.3)$$

for all i and t , where y_{ag} represents the share of agricultural land use, y_{for} is the share of private non-industrial forest land use, and y_{urb} represents the urban/residual land use class, and X is the vector of independent variables described below, and also listed in Table 3.2.

Table 3.2. Descriptive Statistics

Type	Variable, units	Mean	Std.Dev.	Minimum	Maximum
Rent	Livestock Revenue, head x price, \$1,000 ⁺	17.364	20.765	0.726	136.63
	Crop Revenue, bushels x price, \$1,000	15.93	12.388	1.107	70.408
	Farm Profits, \$1,000/farms	3.926	7.811	-12.714	32.681
	Forest Rent, \$100	17.484	75.46	0	809.344
	Population Density (population/mile ²)	162.388	196.893	41.317	1124.37
Policy	Average Net Property Tax Rate, %	6.319	1.45	2.912	14.627
Economic Structure	LQ Tertiary and Higher Sectors	0.669	0.122	0.22	0.9
	Median House Value, \$1,000	52.174	12.616	30.28	87.916
Accessibility	*Accessibility to Indianapolis, pop/d _{ij}	13.825	11.189	5.225	54.867
	Accessibility to Cincinnati, pop/d _{ij}	8.815	1.787	6.338	14.453
	Accessibility to Evansville, pop/d _{ij}	12.213	15.843	4.095	82.003
	Accessibility to Bloomington, pop/d _{ij}	8.042	34.012	0.87	229.059
	Accessibility to Terre Haute, pop/d _{ij}	11.364	5.316	5.057	35.258
	Accessibility to Louisville, pop/d _{ij}	171.905	1377.982	0.637	13712.2

+All prices are in 1997 dollars, 1982=100; *Population is total number of people and distance is in meters

3.3.1 Land Rents

Forest rent is generally represented as the net present value of an infinite series of timber rotations, which are determined by stumpage prices and yield by species. A bareland forest rent calculation for each county in the study area was derived using

growth and yield models calibrated for southern Indiana (Carmean, et al., 1989, Schroering, 1982). The ideal forest rotation length was calculated using an assumed interest rate of 5%. Combining the optimal rotation forest length and deflated prime lumber prices found in Hoover (2000), the net present value of an infinite series of rotations on bareland for the major forest species groups was calculated. A county-level average was derived by weighting this measure by the area of total forestland in each forest species group for each county³. The net present value of returns to timber in forestland use does not reflect the full spectrum of utility, such as aesthetic value, received by private non-industrial owners. The effect of non-market forestland uses such as aesthetics was proxied with population density and residential housing values.

Agricultural rent is represented by the net present value of a perpetual stream of annual crop and livestock revenues, assuming that the current and historical revenue streams can provide an indication for the likely future revenue stream. Land quality is a critical factor in farm production (Parks and Murray 1994). Agricultural rent is measured using deflated output prices, average yields, and slope and soil type. Farm profits and government transfer payments may indicate the financial solvency of a farm.

Agricultural rent was defined as livestock and crop revenues from the US Agricultural Census (US Department of Agriculture, 1969, 1974, 1978, 1982, 1987, US Department of Agriculture, 1992, 1997). Farm profits were also included from the Regional Economic Information System (REIS) data (US Department of Commerce, 2001).

Urban land use, in our model, is by definition non-agricultural or non-forest uses, including industry and residential land. In past studies, urban land use pressure was

³ Total forestland was used, not just NIPF area, under the assumption that timber sales by NIPF landowners, timber industry, and national and state parks collectively determine the price paid to mills. The species groups included poplar, elm-ash, beech, red and white oak, and maple.

proxied by population density (Ahn, et al., 2000, Mauldin, et al., 1999, Parks and Murray, 1994, Plantinga and Buongiorno, 1990). As in prior studies, we include population as an important measure of non-agricultural and non-forest use. Population data was obtained from the United States Population Census 1970, 1980, 1990, and 2000. There is substantial variability in population density in the region, with a mean value of 162, and a range from 41 to 1,234 people per square mile (Table 3.2). We extend this simple model of urban, agricultural, and forest land rents with policy, economic structure, accessibility, and interaction terms.

3.3.2 Policy

We include two policy variables, zoning and average property tax rates. The impact of zoning on land use decision-making is not straightforward, although some theoretical work indicates that zoning may inhibit development of land for urban uses (Fischel, 1985). Others argue that zoning does not impede growth, but rather may cause sprawl through large lot requirements that are common in traditional ordinances (Dowall, 1988). Zoning restricts the ability of landowners to use their property through rules such as limits on construction, timber harvesting, and use of riparian areas. Local governments often face tough choices in determining the tradeoffs between ideal land use policy, and socioeconomic and political contingencies. Unfortunately, some regulations often have unintended impacts, particularly in peri-urban areas.

Rural regions may have limited experience with the negative impacts of uncontrolled development (Esparza & Carruthers, 2000), and their wish to stimulate economic development can lead to a pro-growth orientation (Rudel, 1989; Marcouiller, 1996; Henry et al., 1997). Therefore, the impact of zoning may not be unidirectional

with respect to land use change; some institutions may push urbanization outward, while other rules will restrict urbanization. Some have theorized that local communities may not adopt restrictive zoning, or may not adopt zoning at all, in order to attract new industries (Peterson, 1981, Rudel 1989).

Adoption of restrictive zoning and increasing property taxes are two hypothesized means to control growth. Property taxes influence the cost of holding land, and zoning influences the transaction costs of development. Ideally one would like to ascertain the impact of zoning with inclusion of variation of rules and enforcement, but it is especially difficult to quantify differences in enforcement and plans, especially over time (Feiock and Taveras, 2002). The zoning dummy variables are equal to 1 for existence of zoning and 0 for no zoning at each time point. The existence of zoning was measured at three points in time: in the year 2000, and 15 and 30 years prior to that point. Zoning data was obtained from the county level comprehensive plans and ordinances, as well as conversations with local planning department staff, experts, and outside sources, such as the I-69 Environmental Impact Study (Bernardin Lochmueller & Associates, 2000). In Indiana, counties and municipalities are both able to zone, but the county level zoning variable was chosen because of the interest in peri-urban development; i.e., the county-level plan is thus the greatest restriction on overall development within each county. The zoning dummy variables indicate whether there is review of development at the county level. Average property tax rates were constructed from Indiana State Auditor records with assessed property value and total current taxes.

3.3.3 Economic Structure

Economic structure, such as the residential land market, can also impact the land use decision-making. The value of residential land at the county level is also likely to be positively correlated with the percentage of urban land (Munroe and York 2003), which found that more urban conversion happens in those areas with higher benefits to be gained from urban uses, *ceteris paribus*. Median housing value, obtained from the United States Department of Commerce Census of Population, was included to signify general county level trends in the value of residential property.

To represent heterogeneous preferences for land use mixtures endogenous to the county, the location quotient (or relative concentration) of secondary and higher sectors (all sectors excluding agriculture, forestry and fishing; mining; construction; and manufacturing), is included using county employment data (US Department of Commerce, 2001). Munroe and York (2003) found that the location quotient, a measure of a region's comparative advantage for particular products, for the relative employment concentration in the more extractive sectors (agriculture, fishing and forestry) versus employment concentration in the service sectors of the economy provide an indicator of heterogeneous preferences for forest recreation and aesthetics. As a county shifts from extractive employment to service employment, we expect a resulting shift in valuation of nontimber forest benefits.

3.3.4 Accessibility

A gravity measure for ratio of city population to travel distance from the center of population in 1970, 1990 and 2000 of each southern Indiana county captures the effect of an increasing pull to urban or suburban lifestyles. For each county, the weighted distance

to nearby cities with a population greater than 50,000: Bloomington, Cincinnati, Evanston, Indianapolis, and Louisville was calculated, to represent employment opportunities, cultural influence, suburban pressures, and tourist populations, which affect the land use throughout the region. Overall the rent, policy, economic structure, and interaction variables extend the simple rent models that are common throughout the land use literature (Ahn, et al., 2000, Parks and Murray, 1994, Plantinga and Buongiorno, 1990, Plantinga, et al., 1999).

3.4 Model Selection

The overarching goal in the econometric estimation was to begin with a parsimonious model of land use shares; i.e., that land use is simply a function of relative profitability, or land rent. If these returns at the county level are somehow shaped by land use policies, then the inclusion of a broader set of variables that reflect other incentives should improve the explanatory power of the model. We move from a simple land rent Model 1 adding in policy variables in Model 2, then economic structure variables in Model 3, and accessibility and interaction variables in Model 4 (Tables 3.3, 3.4, and 3.5).

We employed panel techniques to account for structural differences among individual observations. Comparisons were made between group dummy variables (fixed effects), and error component (random effects) models. The fixed-effect model includes a set of county-specific dummy parameters or intercept terms. The fixed-effects model is most appropriate when the differences across units (in this case, counties), are known or hypothesized structural differences, or parametric shifts in the regression function (Greene, 2001). Random-effects formulations also account for variation across units, but

as an individual disturbance, similar to the error term, for each county. In this case, the county-specific differences are thus randomly distributed across counties (Greene, 2001). This formulation is most appropriate when the unmeasured or unmodeled variation across counties is due to exogenous, random shocks (such as climate or business cycle fluctuations).

All regressions were estimated using LIMDEP software v 7.0. Estimation results are presented in Tables 3.3, 3.4, and 3.5. LIMDEP calculates two sets of diagnostics for the significance of group effects⁴. There was no evidence for serial autocorrelation in the error terms, probably due to the time gap between each period. There was no significant evidence of spatial dependence in the land use ratios for any time period. Specification testing indicated that a random-effects formulation was most appropriate for the urban to forest and urban to agriculture models (Tables 3.4 and 3.5), while a fixed-effects formulation was most appropriate for the agriculture to forest model (Table 3.3), similar to the results in our previous analysis (Munroe and York, 2003).

We constructed a nested set of four models to test the necessity of incorporating measures of policy, economic structure, accessibility to proximate urban regions, and interaction terms. The base model included only population density as a measure of the profitability of urban land use, and we progressively added in the remaining variables. Comparisons across models were made via likelihood ratio tests and nonlinear F statistic tests, subject to a χ -squared distribution (Greene, 2001). These likelihood ratio tests

⁴ There is a trade-off between fixed and random-effects models in practice. Fixed effects models do not require the limiting assumption that the county-specific effects are uncorrelated with the regressors, as the random-effects model does. On the other hand, the consistency of the fixed-effects estimator depends on t , or the number of time periods, and thus may be more unreliable for fewer temporal observations (Greene, W. H. *Econometric Analysis*. 4th ed. New Jersey: Prentice Hall, 2001). In some cases, one may have theoretical reasons to justify fixed or random effects, but these reasons may not always conform to the data.

indicate that all models did not benefit by the inclusion of additional variables, at the 95% confidence level, but the agricultural to forest land share did yield better results when the zoning and tax policy variables, measures of housing values and the location quotient for tertiary/higher sectors, accessibility and interaction terms were included at the 90% confidence level.

3.4.1 Results for Share of Agriculture to Forest Land

For this formulation, a fixed effects model was shown to be the most appropriate formulation via a Hausmann test (Greene, 2001). Most variables were insignificant, indicating that the county dummy variables in the fixed effects formulation captured much of the underlying variation in the observed agriculture to forest ratios in these counties (Table 3.3). The amount of explained variation was high, with a constant adjusted R^2 value of approximately 0.89 across all models. A likelihood ratio test indicated that the simple Model 1, which only included agricultural and forest rent variables, yielded the best overall fit.

The variables related to the profitability of agricultural land use, farm profits and crop revenue, were not significant across all the models. Forest rent was positively related to agricultural use, although not significant, while the interaction between forest rent and slope had a negative impact on agricultural use. The agricultural rents, farm profits and crop revenue, were positively related to agricultural use, as was the population density variable, across all the models.

The policy variables were insignificant across Models 2, 3, and 4. Zoning in the current period and 15 years prior was insignificant and positive in the complex Models 2, 3, and 4. Zoning 30 years prior was insignificant and negative. The average tax rate

variable was not significant, but was negative in Models 2, 3, and 4, indicating that areas with high property tax rates have less agricultural land.

Table 3.3. Estimated Results for Agriculture to Forest Share								
Dependent variable ln(agriculture/forest)								
Fixed Effects	Model 1		Model 2		Model 3		Model 4	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Forest Rent	0.0004	0.002	0.0009	0.002	0.0009	0.002	0.0015	0.003
Forest Rent * Slope	0.0023	0.017	-0.0017	0.017	-0.0013	0.018	-0.0091	0.018
Farm Profits	0.0063	0.007	0.0064	0.007	0.0062	0.008	0.0045	0.010
Crop Revenue	0.0122	0.013	0.0105	0.013	0.0115	0.014	0.0178	0.015
Population Density	0.0051	0.002	0.0010	0.002	0.0014	0.002	0.0017	0.006
Zoning			0.1096	0.142	0.1283	0.146	0.2539	0.158
Zoning 15 Years Prior			0.0207	0.122	0.0182	0.124	0.1302	0.131
Zoning 30 Years Prior			-0.1068	0.15	-0.0848	0.151	-0.0467	0.154
Average Property Tax Rate			-0.0165	0.036	-0.0087	0.041	-0.0039	0.161
Median House Value					0.0019	0.005	0.0008	0.018
LQ Tertiary/Higher Sector					-0.3539	0.545	-1.0984	0.776
Accessibility to Cincinnati							0.0215	0.195
Accessibility to Indianapolis							-0.0917	0.078
Accessibility to Terre Haute							-0.0329	0.223
Accessibility to Evansville							0.0011	0.079
Accessibility to Bloomington							0.0533	0.076
Population Density*Tax							-0.0003	0.0003
Population Density*House							-0.00005*	0.00003
Population Density*LQ							0.0053	0.005
House*Tax							0.0015	0.003
Adjusted R ²	0.89		0.89		0.89		0.89	
Log-Likelihood Ratio	-10.04		-8.32		-7.87		2.134	
Model 1 vs. 4		24.35						
* Indicates significance at the 90% level								

The economic structure variables were not statistically significant across Models 3 and 4. The location quotient (LQ) variable was not significant, but negative indicating that areas with a greater concentration of tertiary and higher sectoral employment have less agricultural land. None of the accessibility variables were significant. The median house value was positive, indicating that areas with a stronger residential land market have more farmland relative to forestland.

There were no significant accessibility variables. Accessibility to Cincinnati, Evansville, and Bloomington were positively related to agricultural land relative to forestland, while areas closer to Indianapolis and Terre Haute were negatively correlated

with farmland. The interaction variable of population density and median house value was negative and significant indicating that increasing median home values coupled with increasing population density decreases agricultural land use. Overall the rent variables explained much of the variation in the sample. Model 1 is the most appropriate with a log-likelihood test and threshold of 95% confidence level, although Model 4 is most appropriate if the threshold is relaxed to 90%. Thus, policy, economic structure, accessibility, and interaction variables do capture some of the variation in the decision to farm land relative to hold land as forest.

3.4.2 Results Share of Urban to Forest Land

The random effects model was most appropriate for the urban to forest, indicating that there were structural changes throughout the period that were not captured by a county dummy. The estimated coefficients from the regression on the share ratios of urban/residual to forest land uses are found in Table 3.4. Overall, these models explained less of the variation in the dependent variables than in the agriculture/forest share model, as evidenced by the R^2 ranging from 0.23 to 0.40. As evidenced by the value of the F statistic, Model 1 was superior to the more complex Models 2, 3, and 4, at the 95% confidence level. Thus, the addition of zoning, tax rate, median value, the location quotient for tertiary/higher sector, and accessibility variables did not greatly improve the model. The simple model superiority indicates that the choice between urban and forest land is not easily related to political and socioeconomic factors beyond population pressure, forest and agricultural price information, and slope, although this may be due to aggregate scale of this analysis.

Among the rent variables, forest rent was not statistically significant in any of the models and was positively related to urban uses. Interestingly the crop revenue variable was statistically significant in all models and positively related to urban uses. Population density was positive and statistically significant in Models 1, 2, and 3.

Table 3.4. Estimated Results for Generalized Least Squares of Urban/Residual to Forest Share								
Dependent variable ln(urban-residual/forest)								
Random Effects	Model 1		Model 2		Model 3		Model 4	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Constant	-0.7781	0.1947	-1.0706	0.375	-0.3521	0.723	-1.7010	1.893
Forest Rent	0.0043	0.004	0.0043	0.004	0.0041	0.004	0.0030	0.004
Forest Rent * Slope	-0.0233	0.026	-0.2491	0.026	-0.0221	0.027	-0.0178	0.026
Farm Profits	0.0052	0.008	0.0060	0.009	0.0043	0.010	0.0037	0.012
Crop Revenue	0.0141*	0.008	0.0140*	0.008	0.0150*	0.008	0.0184**	0.008
Population Density	0.0019***	0.001	0.0017***	0.001	0.0020***	0.001	0.0055	0.006
Zoning			0.1493	0.185	0.1897	0.190	0.1037	0.189
Zoning 15 Years Prior			-0.0095	0.193	-0.0083	0.196	0.0140	0.195
Zoning 30 Years Prior			-0.0934	0.201	-0.0909	0.208	-0.1786	0.209
Average Property Tax Rate			0.0402	0.053	0.0243	0.060	0.0976	0.240
Median House Value					-0.0055	0.007	0.0073	0.026
LQ Tertiary/Higher Sector					-0.6031	0.712	-0.8087	0.935
Accessibility to Cincinnati							0.0576	0.072
Accessibility to Indianapolis							0.0239**	0.010
Accessibility to Terre Haute							-0.0289	0.024
Accessibility to Evansville							-0.0067	0.009
Accessibility to Bloomington							-0.0042	0.006
Population Density*Tax							-0.0003	0.0003
Population Density*House							-0.0001	0.00004
Population Density*LQ							0.0040	0.004
House*Tax							-0.0006	0.004
R ²	0.23		0.24		0.26		0.40	
Sum of Squares	68.93		68.4		66.51		54.72	
Model 1 vs. 4	1.97							

* Indicates significance at the 90% level, ** at 95%, and *** at 99%

None of the policy variables were significant. In this model zoning in the current period was positive, although insignificant, whereas zoning 15 years prior was negative for Models 2 and 3, and zoning 30 years prior was negative and insignificant for Models 2, 3, and 4. The average property tax rate was positive and insignificant for Models 2, 3, and 4. Similarly none of the economic structure variables were statistically significant. Median house value was negative in Model 3 and positive in the more complex Model 4. The location quotient was negative in Models 3 and 4.

There was one significant accessibility variable, accessibility to Indianapolis, which was positive. All else equal, areas that are closer to Cincinnati and Indianapolis have more urban land, while those closer to Bloomington, Terre Haute, and Evansville have less urban land. None of the interaction terms were statistically significant. It is fairly clear that the simple rent model is most appropriate for the urban to forest models.

3.4.3 Results Share of Urban to Agricultural Land

Results for the regressions of share ratios of urban to agricultural land are found in Table 3.5. This random-effects model explained less of the variation than the previous models, approximately 0.09 to 0.34 across the models. The most appropriate model was the simple rent model as determined by an F statistic test of the explained variation between the restricted and unrestricted models.

Forest rents were not significant in any of the models and had a positive impact on urban relative to farmland in Models 1, 2, and 3, but forest rent was negative in Model 4. Farm profits were negative and significant in Model 1, while crop revenue was negative and significant in Models 3 and 4. Interestingly population density was not significant in any of the models, although was positively related to urban use relative to farmland.

None of the policy variables were significant in Models 2, 3, and 4. Zoning in the current period and zoning 15 years prior were positively related to urban use in Models 2, 3, and 4, while zoning 30 years prior was negative in all models. The property tax rate was negative and insignificant in Models 2 and 3 and positive and insignificant in Model 4. None of the economic structure variables were significant in Models 3 and 4. Median

house value was negative in Model 3 and positive in 4, while the location quotient was positive in both Models 3 and 4.

Table 3.5. Estimated Results Generalized Least Squares of Urban to Agriculture Share								
Dependent variable $\ln(\text{urban-residual/agriculture})$								
Random Effects	Model 1		Model 2		Model 3		Model 4	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Constant	0.7548	0.338	0.5700	0.664	0.0957	1.268	-0.8106	3.284
Forest Rent	0.0067	0.006	0.0076	0.006	0.0071	0.007	0.0059	0.006
Forest Rent * Slope	-0.0465	0.046	-0.0546	0.046	-0.0537	0.047	-0.0470	0.045
Farm Profits	-0.0263*	0.014	-0.0183	0.017	-0.0093	0.018	0.0092	0.020
Crop Revenue	-0.0190	0.014	-0.0195	0.014	-0.0258*	0.014	-0.0392***	0.015
Population Density	0.0010	0.001	0.0008	0.001	0.0008	0.001	0.0165	0.010
Zoning			0.3002	0.327	0.2726	0.335	0.3547	0.329
Zoning 15 Years Prior			0.2627	0.342	0.2811	0.346	0.3525	0.330
Zoning 30 Years Prior			-0.1789	0.356	-0.2997	0.367	-0.3903	0.359
Average Property Tax Rate			-0.0078	0.094	-0.0481	0.105	0.2201	0.406
Median House Value					-0.0090	0.013	0.0313	0.045
LQ Tertiary/Higher Sector					1.9356	1.251	1.7153	1.631
Accessibility to Cincinnati							-0.2326*	0.132
Accessibility to Indianapolis							-0.0254	0.019
Accessibility to Terre Haute							0.0192	0.045
Accessibility to Evansville							-0.0098	0.017
Accessibility to Bloomington							0.0156	0.011
Population Density*Tax							-0.0009*	0.001
Population Density*House							-0.0002***	0.0001
Population Density*LQ							0.0021	0.007
House Value*Tax							-0.0008	0.007
R ²	0.09		0.10		0.15		0.34	
Sum of Squares	213.91		214.25		202.78		161.00	
Model 2 vs. Model 1			2.50					

* Indicates significance at the 90% level, ** at 95% level, and *** 99% level

The accessibility to Cincinnati was negative and positive in Model 4, indicating that those communities closer to Cincinnati had less urban land relative to agriculture, all else equal. Accessibility to Indianapolis and Evansville were not significant, but were also negative, while accessibility to Bloomington and Terre Haute were positive. Among the interaction terms, the population density and property tax rate interaction variable was negative and significant. The population density and median house value interaction variable was negative and highly significant, at the 99% confidence level. Overall the simple rent model of urban to agricultural land was the best fit using an F statistic test.

All of the models of land use were most efficiently modeled with a simple land rent model. The agriculture to forest ratio model could be the one exception if we relax the efficiency threshold to 90% for the log-likelihood ratio. Random effects models were the most appropriate for both urban land use models, indicating that there are larger structural changes throughout the time period that cannot be captured by county dummy variables. The fixed effects model was most appropriate for the agriculture to forest model, which indicates that there are not significant structural changes in the way people make decisions about whether to farm or hold land in forest. There was one persistent outlier county in all models of land use, Brown County. Brown County includes a significant amount of public forestland and is a vacation and tourist area. The area is extremely hilly with poor soils. Thus, we might expect that the local tourism based economy generates a higher demand for private forestry that extends beyond the forest rents. Brown County neighbors Monroe County, where Indiana University is located, and is a popular housing location for both primary and secondary vacation homes. There were no other counties that were persistent outliers, outliers at all time points, in any of the models. Thus, the models produce consistent outcomes across most of the 40 county region.

3.5 Discussion

Research into non-industrial private forestry has demonstrated that to preserve forestland in the Midwestern U.S., we need to target these landowners. These landowners may be especially hard to target in the face of urban growth pressure as they hold on to land in order to gain from future sales to developers (Hardie, et al., 2001). As illustrated in our models, forest rent is not a significant explanatory variable for amount

of forestland. Other land rents, agricultural and residential, proxied by population density, are significant determinants of the competing agricultural and urban land uses. It is important that we understand the profitability of competing land uses relative to changes in NIPF extent. On a local, individual landowner level, policies such as tax incentives may be effective, although they were not significant in our study, but policy makers must also have a mechanism to account for the broader opportunity cost of NIPF land use relative to other land rents.

Our study provides support for continued research into NIPFs competing land uses, but also presents the puzzle, why are policy, economic structure, and accessibility factors insignificant in land use decision-making. Part of the answer may be evidenced by the random-effects formulation for the urban to forest and urban to agriculture models. A random-effects specification indicates that there are structural changes that are not explained by group dummy variables. The structural changes during this time period, 1970 to 2000, include increased exurbanization and suburbanization, decreased competitiveness of the American small agriculturalist, and changing cultural preferences, such as increased appreciation for environmental services of forests, as well as larger national economic downturns and upturns.

Furthermore, zoning policy implementation also could be considered a random effect, as a dummy variable does not capture much of the variation in zoning implementation. The insignificant relationship between land use ratios and zoning variables may be due to several factors including the multicollinearity between the zoning variables. Most counties keep their zoning in place once adopted, so a county with 1970 zoning typically also has 2000 zoning. There is one exception to this rule, Morgan

County, repealed its zoning in the 1990s. As can be seen in the Figure 3.1, there is variation in the periods that counties adopted zoning, which allows for some variation in all of the zoning variables. In a future study, we plan to incorporate more sensitive measures of zoning, which will enable us to better model counties that are actively planning to protect open spaces and forests, specifically NIPFs.

We also believe that policy decisions are not made in a vacuum. Counties may not adopt zoning until there is a relatively high level of urban development, which could lead to insignificant results in our models. In his study of New England communities, Rudel found that there was a threshold of development that needed to occur before a town was receptive to land use regulation (Rudel, 1989). Although none of our zoning variables were significant, we see lagged effect of zoning policy in many of the models, where zoning in the current period, while zoning 30 years prior has a negative impact (Table 3.4). Again, although not statistically significant, it appears that zoning in the current period is causing deforestation relative to the level of urbanization indicated by the Models 2, 3, and 4 in Table 3.4. We believe that this lagged effect indicates that urbanization impact zoning adoption. Our results are not inconsistent with the theorists who argue that zoning may accelerate urbanization and sprawl, through ordinances such as minimum lot requirements.

In none of the models was the forest rent variable significant. This finding is consistent with our previous study (Munroe and York, 2003). Other studies such as Ahn et al. (2000) have found significantly positive results for this variable but NIPF land use in the Midwest is much less likely to be for profit (Best, 2002, Birch, 1996, Erickson, et al., 2002). Other non-timber benefits of forestland use are more important than the

profitability of the timber for non-industrial private forest landowners, especially for the relatively small parcels common in Indiana. Agricultural rent variables was not significant in the agriculture to forest share model (Table 3.3), which may be due to the fact that agriculture and forest land generally are not in competition with each other, as agricultural lands are relatively flat, while forested land is often fairly sloped. Some of the agricultural rent variables are significant in the urban to agriculture models (Table 3.5), which may be due to the fact that urban and agricultural uses are often in direct conflict, both requiring relatively flat lands. Interestingly the agricultural rent variables were also significant in urban to forest models (Table 3.4), which may reflect this flat, valued for both agricultural and development uses, versus sloped, best for forest and some exurban development, relationship.

3.6 Future Directions

This study did not uncover a significant relationship between zoning adoption. In future research we should address the apparent threshold effect uncovered in this study, which may have limited the significance of the dummy variables. Many communities will not adopt zoning until there is a significant amount of land that has urbanized. A system of equations approach should include zoning, percent developed land, and housing starts and address the simultaneous relationship between zoning, economic development, and land cover change. The econometric research may also be extended to the entire state of Indiana, which may allow further investigation into the relationship between agricultural use and zoning. It may be possible to represent the variation in implementation and enforcement via a zoning index, which may further our understanding of the relationship between zoning and land use. Furthermore, a study of

areas employing more modern zoning laws, such as use of impact fees and urban growth boundaries, may uncover a different impact on land use decision-making.

Our models indicate that the impact of zoning on forestland decision-making is complicated with differing impacts of historic and current policy. Our findings illustrate a need for further research on the relationship between land use and policymaking because of the apparent interactions between land use changes and local policymaking. The purpose of this study was to assess the broad impacts of zoning instead of focusing on isolated impacts within particular jurisdictions. Our results at the regional scale do not refute the claim that zoning, through policies like minimum lot requirements, accelerates peri-urban development, but neither do we find conclusive evidence that zoning causes sprawl. Rather we found clear evidence of the importance of land rents in land use decision-making, as well as evidence of structural changes in urbanization processes.

3.7 Conclusion

As can be seen the impact of zoning on land cover change is unclear, especially at a regional level. The muddy relationship between land cover and land policy may be due to the conflict filled, complex land policy arena that we discussed in the previous chapter. It is difficult for communities to adopt and implement a plan with clear objectives for forestland and farmland protection, as indicated by the limited number of counties with clear, objective goals included in their plans. At the regional level in our 40 county study area it appears unclear whether zoning, as currently implemented, is protecting natural resources. In the next chapter, we explore the relationship between zoning and parcel level fragmentation of forestland. Forest fragmentation limits the ability of parcels to offer environmental services, such as providing habitat for wildlife or being economically

viable timber stand. It is important to understand how zoning rules impact one measure of environmental soundness. This analysis is within one zoning regime, Monroe County, so some there may be a clearer relationship between land policy and impact on land.

Chapter 4: Fragmentation and Zoning in an Urbanizing County

We explored zoning's impact on land use and land cover change in the previous chapter. We were unable to uncover significant effects on land cover of zoning implementation. Possibly this may be an urbanization threshold for zoning policy adoption. There was an insignificant lagged effect of zoning indicating zoning may protect conversion of forested land under some conditions. The pattern of land use conversion is important, as well as the aggregate level of conversion within a county, as a more compact and connected pattern of development will limit impacts on agricultural and forestland uses. In this chapter, we explore these patterns and assess the impact of zoning at the parcel level with respect to fragmentation.

Darla K. Munroe, Cynthia Crossaint, and Abigail M. York¹

4.1 Introduction

Urban and suburban development, or the conversion of rural agricultural and forested lands to mostly residential uses, is now the greatest source of landscape and forest fragmentation in the United States, as in many other regions. Because much of the landscape is privately owned, effective land use policy must target private landowners. The degree of fragmentation of forest land cover is of particular importance due to the environmental benefits of forests: habitat provision, prevention of erosion, and their role in the global carbon cycle. Land managers have attempted to lessen landscape fragmentation by regulating land uses on private lands and by preserving forests and open

¹ A version of this chapter is an article forthcoming in *Applied Geography*, "Land Use Policy and Landscape Fragmentation in an Urbanizing Region: Assessing the Impact of Zoning," by Darla K. Munroe, Cynthia Crossaint, and Abigail M. York. There is an added introduction and conclusion to connect the article to the rest of the dissertation, as well as some editing within the text.

spaces (Karasov, 1997). Land use policy shapes land use patterns, which are in turn influenced by the biophysical and socioeconomic environment. To identify the ultimate influence of policies such as zoning in mitigating landscape fragmentation, the complex relationships among all these factors must be better understood.

In the United States, as in other areas, local governments combat landscape fragmentation by controlling the type and location of land uses through planning and zoning regulations (Feiock & Taveras, 2002; Razin, 1998). Zoning is not a panacea, however, and zoning has not always been used to minimize fragmentation (Platt, 1996; Feiock, 1994). Zoning plans generally reflect a variety of political interests and stakeholders. Local governments also face a balancing act in attempting to maintain broad political support, keep service costs low, and maximize the residential tax base. Rural areas proximate to urban centers have an incentive to keep their policies less restrictive in order to capture new residents perhaps moving out of the urban areas. In fact, inconsistent zoning across jurisdictions may contribute to fragmentation by pushing residential development into rural areas (Carruthers, 2003).

Landscape fragmentation results from the complex interaction between policy, biophysical characteristics, and socioeconomic development pressure. Residential land use is shaped and influenced by many factors relating to land use returns, including parcel characteristics, accessibility to cultural and employment centers, and policy restrictions governing use. If the amount and spatial configuration of agricultural and forest lands are to be effectively preserved, an improved understanding of the relationships between landscape fragmentation, location, and topographic characteristics is essential (Ward et al., 2000). Spatial analytical techniques can be of great value to

policy makers in determining the spatially explicit implications of current and future development.

This research attempts to frame geospatial analytical approaches with insights from land use planning theory, as means to provide guidance and support for the planning process, as well as a greater understanding of the relative impact of various determinants of land use in an urbanizing county with diverse land uses, including large areas of forested land and some agricultural production. In particular, it provides a better understanding of relationships among land-use policy, socioeconomic characteristics, locational attributes, physical characteristics and measures of landscape fragmentation. Landscape fragmentation is measured using the tools of remote sensing and Geographic Information Systems (GIS), and relationships are determined by using statistical tests for multivariate independence.

In this analysis, we test the hypotheses that landscape fragmentation varies across areas with different zoning policies, and that this relationship still holds when accounting for topographical and socioeconomic differences. To answer these questions, we examine the statistical relationship between zoning policy and landscape fragmentation both at the scale of the county and on individual parcels. Two measures of configuration are used to indicate the degree of fragmentation. Interspersion of land cover types provides one indicator of land fragmentation. The largest patch index for forest land cover suggests the relative concentration of forest cover and provides a second indicator of forest fragmentation. Several measures of parcel characteristics (parcel area, percent land area with slopes greater than twelve degrees), landowner characteristics (gross income), and parcel accessibility (proximity to major roads and towns) are also

considered. The statistical relationships between the ranked distribution of each of the above variables and the two measures of landscape fragmentation are found using a contingency table analysis. Correlations among all variables are calculated, and changes in the magnitude of these correlations with or without controlling explicitly for zoning are determined. We find that the diversity of land uses is much higher, at the aggregate level and at the parcel level, in areas that are zoned to allow for the highest housing density and smallest lot sizes. These results are still robust after accounting for key geophysical and accessibility characteristics of the individual parcels.

4.2 Relevant Literature

For an integrated, comprehensive overview of the forces that shape land use in a spatially-explicit manner, researchers must consider the interacting influences of socioeconomic drivers of land use, local policy, and the environment within which this land use occurs.

It is well established that landscape fragmentation has profound implications for the health and viability of ecosystems. It has also been noted that landscape fragmentation is often costly from a socioeconomic perspective (Entwisle, et al., 1998; Civco et al., 2000). An area in which sprawl is occurring may be characterized by spatially heterogeneous land cover particularly along the urban-rural interface or boundary. Development may lead to a loss of farmland or forest land, increased commuting time for the new residents, and increased public expenditures for education, roads, and sewer, as well as perpetuating the problem of sprawl.

Sprawl can arise both from private sector activity and public policy failures. Urban and suburban developments often occur in former agricultural and forest areas

because residents are drawn to the rural character, leisure opportunities, and ecosystem services of these areas. This process is then reinforced when subsequent multiple employment centers are created through commercial development (Anderson & Bogart, 2001), driving further residential development outside of the traditional suburban areas (Vias et al., 2002). Residential land users in peri-urban or ex-urban areas often place a great premium on the aesthetic value of their property. Unfortunately, residential growth in rural areas threatens the very resources that exurbanites were attracted to in the first place.

4.2.1 Land Use Policy

Local governments often face tough choices in determining the tradeoffs between ideal land use policy and socioeconomic and political contingencies. The primary tool for community land managers to lessen or prevent landscape fragmentation is the zoning ordinance, which is based upon a comprehensive land use plan, and is designed to regulate allowable uses especially on agricultural, forest, and conservation reserve lands. Unfortunately, some regulations often have unintended impacts, particularly in peri-urban areas. First movers often attempt to regulate further growth through zoning and land use planning policy, which can decrease social welfare as the supply of suburban lands is constrained within a jurisdiction, but the demand for suburban lifestyle is not curbed (Feiock, 1994; Fischel, 1982). Minimum lot size restrictions, as found within the agricultural reserve zones, may actually lead to residential development on larger parcels than would be found without this requirement (Esparza & Carruthers, 2000). Rural regions may have limited experience with the negative impacts of uncontrolled development (Esparza & Carruthers, 2000), and their wish to stimulate economic

development can lead to a pro-growth orientation (Rudel, 1989; Marcouiller, 1996; Henry et al., 1997). Thus, to prevent land fragmentation at the level of individual parcels, better knowledge and study of how zoning actually shapes land use is required. The next section formally discusses fragmentation, relating this issue to variations in land policy, topography and access to economic and cultural amenities.

4.2.2 Landscape fragmentation

The observed spatial configuration of land uses is the collective result of myriad factors that influence the returns, or benefits, to land use (Munroe & York, 2003). The term “benefit” encompasses both formal profit as well as non-pecuniary factors, such as aesthetic value. Landscape ecological techniques can directly link the observed spatial configuration of land uses to drivers of land use returns.

The study of landscape fragmentation grew out of conservation biology and evolved into the field of landscape ecology. To quantify the degree of fragmentation in a landscape, both composition and configuration of the components of the landscape are considered, as measured by the number and distribution of patches or distinct (non-adjacent) areas of the same land cover type (O'Neill & Hunsaker, 1997). Patterns evident in spatial metrics can be used to infer ecological functions. For example, habitat fragmentation may lead to a decline in biological diversity and the ability of ecosystems to recover from disturbance. Differences in forest fragmentation have also been associated with human impacts on the landscape. For example, significant differences in forest fragmentation are associated with differences in zoning policies (Croissant and Munroe, 2002) and the urbanization pressure gradient (Wickham et al., 2000).

Prior research has pointed to several factors to consider in explaining a particular spatial configuration of land use. Levia (1998) found distance to city center, nearby highways, and parcel size to be related to the probability of conversion of farmland to residential use in Massachusetts. LaGro and Degloria (1992) identified population density and proximity to highways as being related to urban development probabilities in a land-use study in New York state. Although it is clear that human impacts affect spatial landscape patterns, aspects of the relationships between differences in zoning policies and differences in patterns remains unclear. Previous research (Croissant and Munroe, 2002) demonstrated a correlation between land policy and fragmentation. This analysis delves further into the relationship between zoning and fragmentation by specifically examining the cross-correlation between fragmentation and other relevant factors. First, we examine the correlations among measures of landscape fragmentation , parcel characteristics, accessibility, and zone type. Secondly, we test whether the correlations among biophysical characteristics, accessibility, and landscape fragmentation, become stronger after accounting for the mediating influence of zoning.

4.3 Site Description

Monroe County, Indiana, typifies a growing debate regarding the tradeoffs to socioeconomic growth and development, and its impact on the landscape. Within Monroe County, Indiana, a wide range of land uses and land covers coexist. The city of Bloomington, which is the economic, cultural, and governmental center of Monroe County seat, is located in approximately the middle of the county (Figure 4.1).

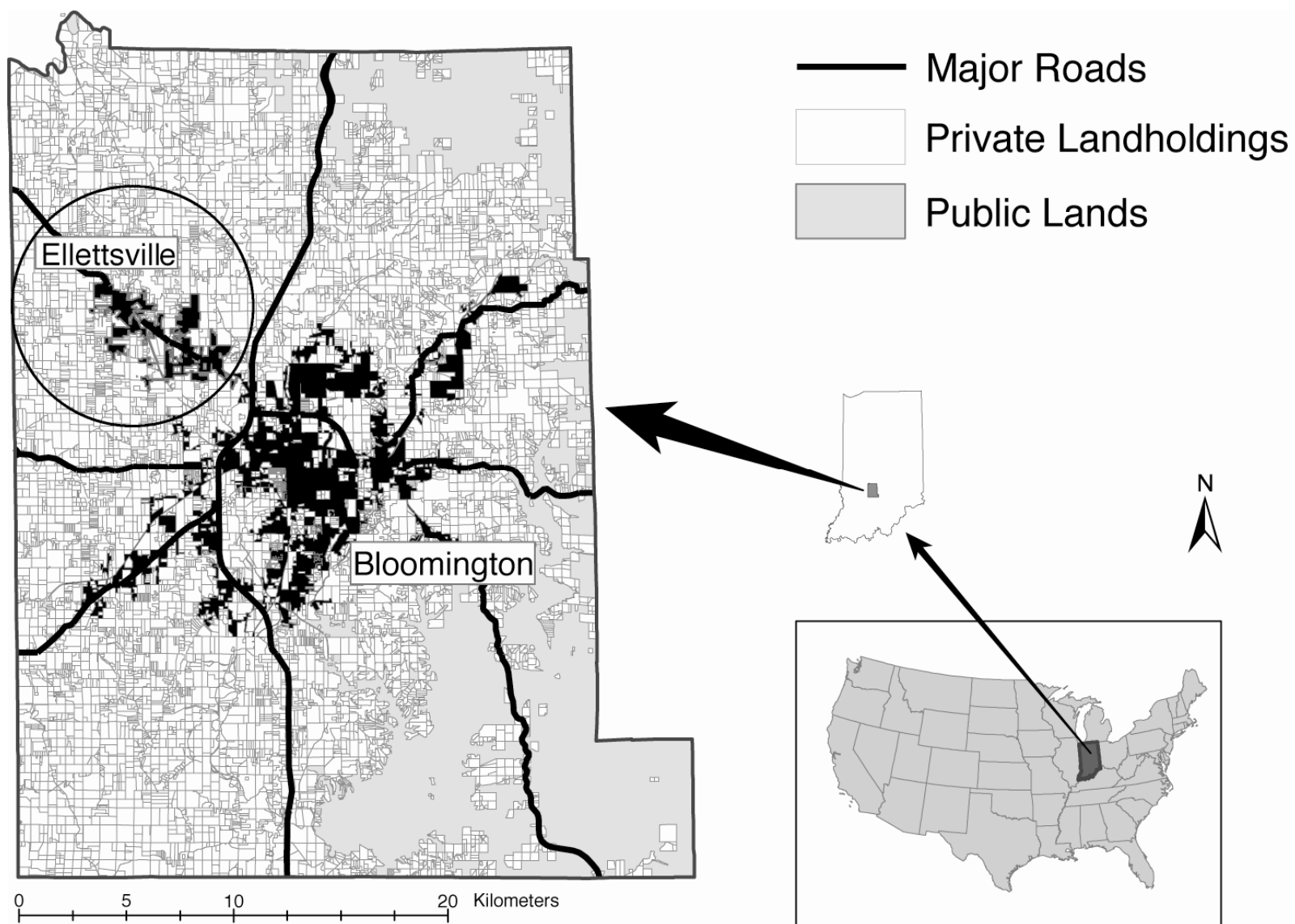


Figure 4.1. Public and Private Land Holdings in Monroe County, Indiana

Bloomington is somewhat unique in the region of southern Indiana in that it is experiencing relatively rapid urban growth. Over the last five decades, Bloomington grew at one of the fastest rates in Indiana, moving from the 19th to the eighth largest city in the state (Monroe County Environmental Commission, 2001).

Forests are an important component of the landscape of southern Indiana. In contrast to the glacially impacted northern portion of the state, southern Indiana is composed of hilly terrain with relatively thin, poor soils. The hills and steep topography have made some lands unattractive for modern agricultural use and secondary forests have been allowed to re-grow. In general, the secondary forests in southern Indiana are viewed as the last “natural” landscape surrounded by disturbances such as urban and agricultural lands. Approximately 87% of the Indiana’s forest cover is on private land. Part of the difficulty in managing the forests of southern Indiana is the large number of private forest land owners and fragmentation of management. Fragmentation of forest habitat and ownership comprise one of the largest threats for sustainable use of the forest resources (Petersen, 1998).

A comprehensive plan may include the guiding principles for the application of various types of zones, as well as the overall goals of the community land use planning (Ellickson & Been, 2000). In Monroe County, the local legislative body, the County Council, votes on the comprehensive plan and zoning ordinances while appointed officials implement and enforce the plan in conjunction with the Planning Department. The comprehensive plan guides the implementation of the zoning ordinances. The allowable uses for each zone frequently are related to parcel characteristics such as the degree of slope, the size and shape of parcels, and soil type, which may indicate whether

agriculture, residential development, or forestry is viable. Residential development is highly compatible with agriculturally viable land, thus communities often face choices regarding the preferred use of home development or agricultural land preservation within comprehensive plans. Within Monroe County, there are four separate land use regulatory bodies, Monroe County, the city of Bloomington, the town of Stinesville, and the town of Ellettsville. Ellettsville has recently become a “bedroom community” for people who work in the city of Bloomington due to substantially cheaper land values. The 251 parcels selected for this study are residential parcels that are located in a “no-man’s land”, outside the boundaries of any city or town. It is precisely in these areas where one would expect to see effects on the landscape of incomplete or inconsistent land use policies. All of the parcels are located in areas that fall under the zoning regulations of either the county or the city of Bloomington. As shown in Table 4.1, the zones differ in terms of the housing density and minimum lot sizes that are permitted. Figure 4.2 illustrates where these zones are in effect.

Table 4.1. Monroe County Zoning Categories and Summary of Metrics by Zone

Name	Primary Intended Purpose	Gross Density	Minimum Lot Area (acres)	Area, km ²	LPI_F (1-100)	IJI_L (1-100)
Agriculture/ Rural Reserve (AG/RR)	To provide areas for single-family residences associated with agriculture uses.	0.20-0.40	2.5	474.25	3.49	68.93
Conservation Residential (CR)	To provide a residential option at environmentally sound locations while protecting the environmentally sensitive areas.	0.40	2.5	17.44	12.45	68.01
Forest Reserve (FR)	To preserve forests, recreational areas, parks and greenways; limit agricultural uses and low-density single-family residential uses.	0.20	5.0	300.77	27.39	49.76
Estate Residential and Suburban Residential (ER/SR)	To allow low density, single-family residential development on relatively flat land in areas that have some, but not full, public services.	1.00	1.0	32.55	1.89	81.83
Bloomington Fringe Residential (Fringe)	To provide a transition zone: this zone is similar to the estate residential and suburban residential except it was created under the jurisdiction of the city of Bloomington.	Most of this area 1.00-6.00	Lots described as “large”	39.18	10.62	78.16
County Total				1,064.41	23.22	73.10

Source: Monroe County Planning Commission, Chapter 804: Zoning Ordinance: Height, Bulk, Area, And Density Provisions 1995; and authors’ calculations using PatchAnalyst.

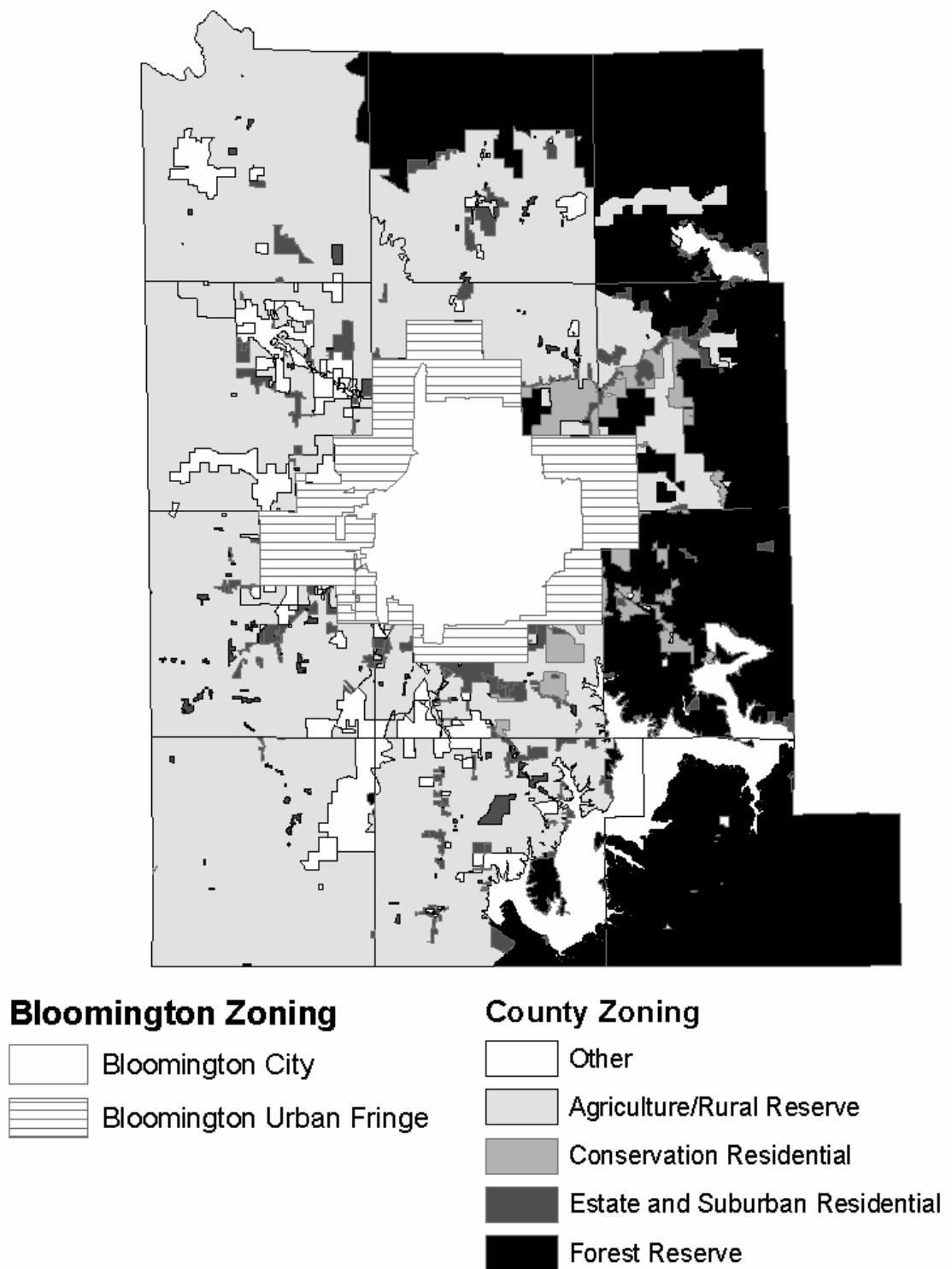


Figure 4.2. Monroe County Zoning Boundaries

4.4 Data and Methods

A map of land use and land cover was produced from a supervised classification of a remotely sensed Landsat Thematic Mapper image from September 1997 (Figure 4.3). The resulting classes are ones that are intuitive and easily understood (following Anderson et al. 1976). The classification contains some classes that refer to a type of land cover such as forest and other classes that encompass aspects of land use such as agriculture. Although land use and land cover are often considered together and are closely related, there are distinctions between the two terms. Land cover refers to the surface cover on the ground such as forest, urban infrastructure, or water. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture (Brown et al., 2000). The classes derived from remote sensing techniques usually relate to land cover, from which land use can be inferred, particularly with ancillary data. Information obtained from interviews and field work enables the identification of general types of land use such as agriculture.

A limitation of this analysis is the spatial resolution of the remotely sensed imagery data used to create the map of land use and land cover. Because the minimum cell size of the data was 900 m^2 , it was not possible to distinguish very fine variations in land use and land cover, but general trends in broadly defined classes can be identified. The classification used consists of: 1) all forest including secondary succession, 2) developed areas including areas of residential and commercial land use, quarries, and concrete, 3) agricultural areas including row crops and pasture, and 4) water (Croissant, 2001).

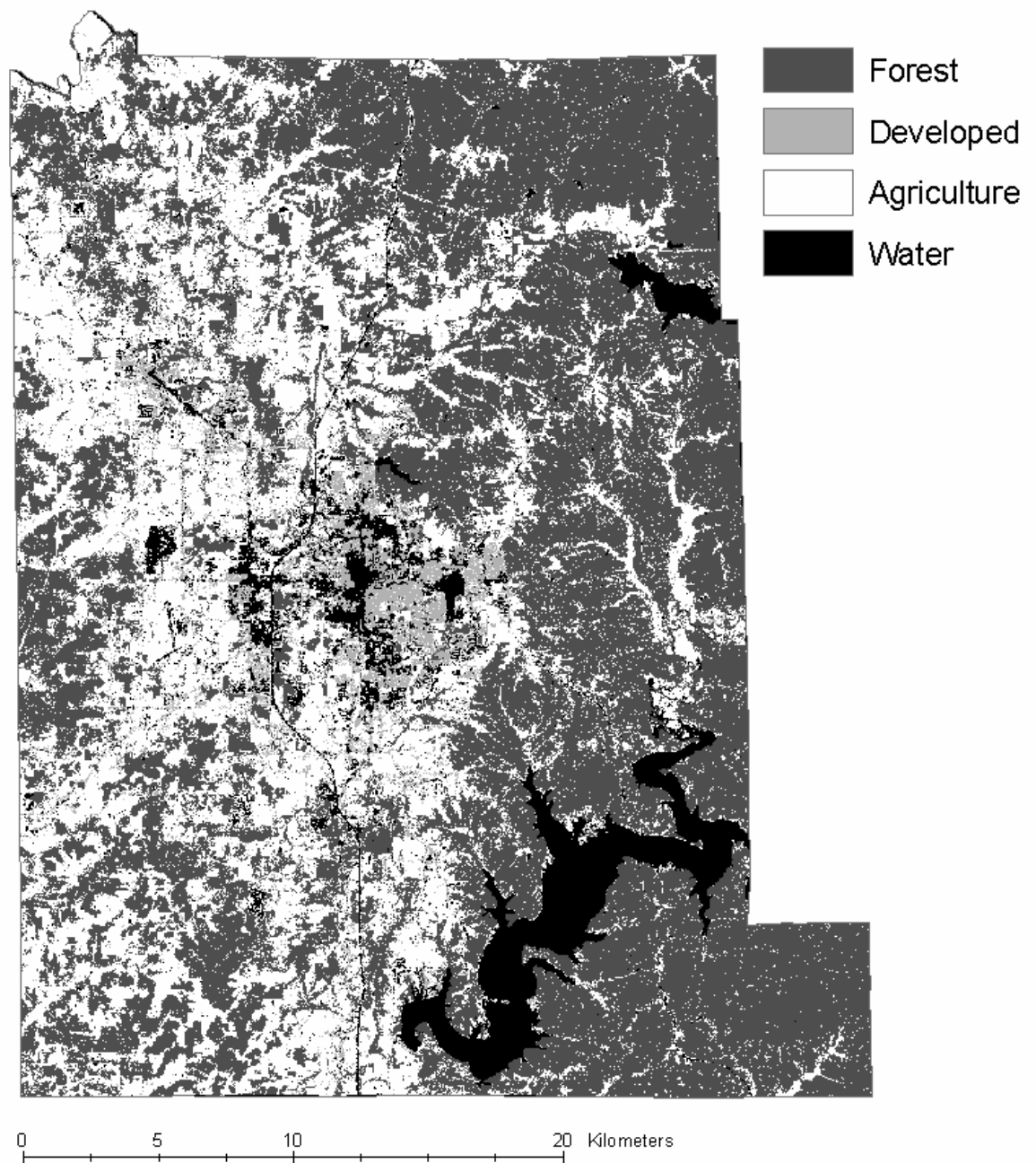


Figure 4.3. Land Use/Land Cover Classes for Monroe County, 1997

In the classification, pixels are assigned to one class although in reality the land may be a mix of several classes. For example, there exist agricultural lands that contain trees and land that was formerly used for agriculture that is becoming reforested. Several steps were taken to provide the most accurate separation of areas of agriculture from areas of forest. Advanced secondary succession (the most mature forest or SS3) were derived from the Ecological Classification System of Van Kley (1993). Initial secondary successional forests were obtained from forest plot data spatially reference using global positioning (GPS) receivers. These initial successional forest sites were formerly timber clear-cuts or abandoned agricultural fields. Because of the degree of confusion between initial and advanced secondary successional forest, these two classes were combined.

Agricultural areas including row crops and pasture were identified based on information obtained during interviews with private landowners conducted during the summer of 1998 and ground truthing using GPS receivers. The resulting classification had an overall accuracy of 95% with a Kappa Statistic of 0.92. The Kappa Statistic measures the observed agreement between the classification and the reference data verses the agreement that might be attained solely by chance matching (Campbell, 1996). Some degree of confusion between classes is inherent when assigning pixels to a limited number of classes. This problem is here minimized because of the relatively high degree of accuracy in the classification and the rigorous methods used in its creation.

Landscape fragmentation was measured at the aggregate level within each zone type, and then at the scale of individual parcels using the sample of 251 parcels. Two indicators of landscape configuration were used. First, the largest patch index for forest land cover (LPI_F) measures the relative concentration of forest cover, or the percentage

of total area covered by the largest patch of forest. The concentration of forest cover is particularly relevant for species richness (MacArthur & Wilson, 1967; McGarigal & Marks, 1994). This measure focuses exclusively on the spatial configuration of forest rather than all types of patches and it has been shown to be an important indicator of forest fragmentation (Wear et al., 1996; Wickham et al., 1999).

The second indicator of configuration measures the degree to which patches of one type (forest, agriculture/pasture, and developed) are juxtaposed with patches of other types of land use and land cover in the landscape. This measure is calculated using the interspersed-juxtaposition index for all land cover types across the entire landscape (IJI_L). The IJI_L index is useful in measuring the degree to which all patch types within a landscape are adjacent or interspersed with each other. It is the observed interspersed divided by the maximum interspersed for the number of patch types, defined as:

$$IJI_L = \frac{-\sum_{i=1}^{m'} \sum_{k=i+1}^{m'} \left[\left(\frac{e_{ik}}{E} \right)^{\ln} \left(\frac{e_{ik}}{E} \right) \right]}{\ln(1/2[m'-1])} (100) \quad (4.1)$$

Where:

- m' = Number of patch types or classes present in the landscape, including the landscape border if present
- $i = 1, \dots, m$ or m' patch types or classes
- $k = 1, \dots, m$ or m' patch types or classes
- e_{ik} = Total length (m) of edge in landscape between patch types or classes (distinguished by i and k)
- E = Total length (m) of edge in landscape

Each patch is evaluated for adjacency with all other patch types. For the raster cells on the perimeter of patches, the total length of each unique edge type is determined.

It approaches zero when the distribution of unique patch adjacencies becomes uneven and 100 when all patch types are equally adjacent. Higher values result from landscapes in which patch types are well interspersed or are equally adjacent to each other. Low values characterize landscapes in which the patch types are poorly interspersed with discorporate distribution of patch type adjacencies. IJI_L is not affected by the size, contiguity or dispersion of patches.

The IJI_L measures interspersion only, not dispersion (or the extent of isolation of patches of like type), which can be quantified using a contagion index. However, the IJI_L is able to construct patch-level (rather than cell-level) analysis, which is most appropriate given the resolution of the land cover data. A higher value typically indicates greater fragmentation.

4.4.1 Landscape Configuration by Zone

Table 4.1 presents a summary of policies regarding each zone type, as well as the two metrics calculated for each measure. At the county level, interspersion is high, and the largest patch index for forest is low, and the results by zone are not surprising. The estate/suburban residential has the highest interspersion and the lowest value for the largest patch index for forest. The agricultural/rural reserve zone has lower than average interspersion, but also second to lowest values for LPI_F. The “fringe” zone has both higher than average IJI_L and lower than average LPI_F. As shown in Table 4.1, the estate/suburban residential and fringe zones allow for relatively high density housing development on relatively small lots. These results indicate a connection between housing density or lot size and landscape fragmentation and support the findings of

Marzluff and Ewing (2001) who proposed that dispersed development is better for protecting bird populations.

4.4.2 Landscape Configuration by Parcel

In analyzing land use and land cover fragmentation from a socioeconomic perspective, the use of landscapes corresponding to individual parcel boundaries is preferred over the use of more biophysically based boundaries (Irwin & Geoghegan, 2001). Given this preference, a sample of 251 privately owned parcels that have non-industrial uses was chosen for this analysis based on a stratified random sample of parcels over five acres (about two hectares) in size within Monroe County. The size of the parcels in the sample range from roughly 5 to 150 acres (or 2.02 to 60.7 hectares). The values of the metrics at the individual parcel level were correlated with other, hypothesized drivers of landscape pattern.

A measure of the degree of slope is included in this analysis because it can have a great impact on the land use and land cover in an area (Evans et al., 2001). Steep slopes can greatly limit both development in areas not served by municipal sewer systems and decrease suitability for agricultural uses. In an effort to reduce erosion, secondary forests have been planted in some areas with steep slopes. Parcel size was also included in analysis. Parcel size is related to zoning in that certain types of zones require larger lots and development tends to follow parcel subdivision (Levia, 1998; Walker, 2001). In addition, parcel size may indicate a wealth effect; individuals with larger parcels may be more likely to depend on the land for income (from agriculture or forestry) (Koontz, 2001), affecting the observed configuration of land uses.

Data on zoning, slope, and parcel size were entered into Arc/Info GIS. Slope data were obtained from a 1:10,000 scale digital elevation model, obtained from the USDA Forest Service. Zoning within the county jurisdiction (Figure 4.2) and parcel boundaries from approximately 1998 were obtained from maps produced by the Monroe County Planning Office (Camiron, 1991; Monroe County Plan Commission, 1995). The distance between the centroid of each parcel to downtown Bloomington and Ellettsville was calculated using the GIS and is included as a measure of access to cultural and economic amenities. Landowner income was included as a proxy for the likelihood of owners to depend on their land for productive purposes (agriculture or non-industrial forestry). Table 4.2 presents a description of all variables considered. Measures of the degree of landscape fragmentation on the parcels were calculated using Patch Analyst (Rempel and Carr, 2003) at both the parcel and the county level. The largest patch index value for forest cover (LPI_F) and the interspersation/juxtaposition index for the entire landscape (IJI_L) were calculated for all 251 parcels included in the sample. The parcel level analysis proceeded in two stages: (1) examining whether the indices of landscape fragmentation and geophysical, socioeconomic, and policy variations were statistically related in terms of their ranking from low to high; and (2) for those factors that were significantly related to the indices, measuring the magnitude of the correlation among these interrelated factors and the indices of fragmentation.

<u>Variables</u>	<u>Units</u>	<u>Source, Description</u>
Parcel Size	square meters	Monroe County Auditor
Percent Slope > 12	percent area	Derived from a Digital Elevation Model with 10m resolution
Landowner Income	dollars	Landowner survey
Distance to Bloomington City Center	meters	Euclidean distance between parcel centroid and city center
Distance to Ellettsville City Center	meters	Euclidean distance between parcel centroid and city center
Distance to I-37	meters	Euclidean distance between parcel centroid and nearest point on road network
Distance to I-46	meters	Euclidean distance between parcel centroid and nearest point on road network
Zone Type	nominal	Monroe County Planning Commission
Largest Patch Index, Forest Cover	index 1 - 100	Derived from 1997 classification of Landsat TM image using PatchAnalyst©
Interspersion/Juxtaposition Index, All Land Cover	index 1 - 100	Derived from 1997 classification of Landsat TM image using PatchAnalyst©

Table 4.2. Description of Data

Hypothesis 1: Landscape fragmentation and configuration are significantly correlated with parcel characteristics, accessibility, and zone type.

Each variable was ranked from lowest to highest. This method avoids issues of non-linearities and statistical outliers in the underlying distributions of these variables. The rankings for each variable were grouped, by percentiles, into three categories (low [0-33%], medium [33-66%], and high [66-100%]).

4.4.3 Contingency Table Analysis

The categories (low, medium, and high) for two variables are cross-tabulated, and then the frequency of occurrences in all possible categories for each variable were determined. These contingency tables were subjected to a χ^2 test on observed versus expected frequencies. The expected frequency is defined as:

$$F_{ij} = \frac{R_i C_j}{n}, \quad (4.2)$$

where R_i is the sum over row i , and C_j is the sum over column j . The test statistic is:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \frac{(f_{ij} - F_{ij})^2}{F_{ij}}, \quad (4.3)$$

where f_{ij} represents the observed frequencies (Burt & Barber, 1996).

The two landscape metrics (LPI_F or the largest patch index for forest, and IJI_L or the interspersed/juxtaposition for all classes in the landscape) were compared to zone type, distance to Bloomington city center, distance to Ellettsville city center, parcel size, income, and the percentage of the parcel with slope greater than 12 degrees. These results are reported in Tables 4.3, 4.4, and 4.5. A p-value of less than 0.05 indicates significance at the 95% confidence level.

		<u>Zone Type</u>					Total
		AG/RR	CR	FR	ER	Fringe	
LPI_F	Low	63	3	2	3	12	83
	Med.	62	4	9	1	8	84
	High	32	6	37	1	8	84
	Total	157	13	48	5	28	251
$p = 0.00$							
		AG/RR	CR	FR	ER	Fringe	Total
IJI_L	Low	40	5	31	1	6	83
	Med	59	2	9	2	12	84
	High	58	6	8	2	10	84
	Total	157	13	48	5	28	251
$p = 0.00$							

Table 4.3. Contingency Table for Landscape Metrics by Zone Type

		<u>Distance to Bloomington</u>			Total
		Low	Med.	High	
LPI_F	Low	30	29	24	83
	Med.	33	29	22	84
	High	20	26	38	84
	Total	83	84	84	251
p = 0.06					
IJI_L	Low	25	28	30	83
	Med.	31	31	22	84
	High	27	25	32	84
	Total	83	84	84	251
p = 0.51					

		<u>Distance to Ellettsville</u>			Total
		Low	Med.	High	
LPI_F	Low	42	25	16	83
	Med.	29	25	30	84
	High	12	34	38	84
	Total	83	84	84	251
p = 0.00					
IJI_L	Low	15	27	41	83
	Med.	36	27	21	84
	High	32	30	22	84
	Total	83	84	84	251
p = 0.00					

Table 4.4. Contingency Table for Landscape Metrics by Distance to City Centers

		<u>Income</u>			Total
		Low	Med.	High	
LPI_F	Low	24	20	12	56
	Med.	23	22	18	63
	High	19	25	21	65
	Total	66	67	51	184
$p = 0.56$					
		Low	Med.	High	Total
IJI_L	Low	22	20	20	62
	Med.	18	23	17	58
	High	26	24	14	64
	Total	66	67	51	184
$p = 0.62$					

		<u>Parcel Size</u>			Total
		Low	Med.	High	
LPI_F	Low	27	30	26	83
	Med.	25	24	35	84
	High	31	30	23	84
	Total	83	84	84	251
$p = 0.37$					
		Low	Med.	High	Total
IJI_L	Low	26	27	30	83
	Med.	20	25	39	84
	High	37	32	15	84
	Total	83	84	84	251
$p = 0.00$					

		<u>Area of Slope > 12 Degrees</u>			Total
		Low	Med.	High	
LPI_F	Low	53	27	3	83
	Med.	23	41	20	84
	High	7	16	61	84
	Total	83	84	84	251
$p = 0.00$					
		Low	Med.	High	Total
IJI_L	Low	8	25	50	83
	Med.	31	37	16	84
	High	44	22	18	84
	Total	83	84	84	251
$p = 0.00$					

Table 4.5. Contingency Table Test for Landscape Metrics by Parcel Characteristics

The results show that the distribution of the landscape metrics by zone type was highly significant. The range of LPI_F was low to medium in parcels zoned as Agriculture/Rural Reserve, and also low in the urban fringe area around the city of Bloomington (Fringe). Not surprisingly, the greatest number of high values of LPI_F were found in parcels zoned as Forest Reserve. Conversely, parcels zoned as Forest Reserve had low values of IJI_L (or landscape interspersions), and Fringe parcels had high levels of IJI_L. Therefore, those parcels with the least restrictive zoning policies – that is the highest housing densities and smallest lot sizes or those in the Fringe – were seen to have the most diverse land use mixtures.

There was no statistically significant relationship between the values (low to high) of LPI_F and IJI_L for the ranges of distance to Bloomington or landowner income. The range of distances to Ellettsville and the ranges of LPI_F and IJI_L were strongly correlated, however. LPI_F was high farthest from Ellettsville and low closest to Ellettsville. For IJI_L, nearly the opposite was true (though there was not as clear a trend for low values). The range of parcel sizes was not significantly related to the range of LPI_F, but IJI_L tended to be higher on smaller parcels and lower on larger parcels. This finding makes intuitive sense, because one might expect to see a wider variety of uses on smaller suburban parcels, or parcels on the urban fringe, especially if deriving income (through say agricultural production) was not a major activity of most of the landowners (Koontz, 2001).

The clearest trend overall was the relationship between the percentage of area covered by greater than 12 degrees slope and the two landscape metrics. Steeper areas had higher values of LPI_F and lower values of IJI_L, and vice versa. Therefore, it

appears that topography, zoning, and distance to Ellettsville are all related to the degree of landscape fragmentation. However, given the history of land use in Monroe County, particularly the relationship between urban growth and development around Ellettsville, further investigation of the interrelationship among these three factors was warranted. Topography and ease of development are clearly related. Because Ellettsville is situated on some of the flattest land in the county, it is also then the most easily developed. It is also an important bedroom community for Bloomington due to easy access and cheap land. Therefore, topography is not the sole explanatory factor for this finding.

Hypothesis 2: To understand the relationship between biophysical characteristics, accessibility, and landscape fragmentation, one must specifically account for the effect of zoning.

The above analysis indicates that indices of landscape configuration are not statistically independent of zone type, parcel characteristics, and access to regional centers. To determine the strength of the correlation between these indices and the most statistically significant factors from the last section, a statistical test for the equality of dependent correlation coefficients was performed (Dunn & Clark, 1971).

First, Pearson's correlation coefficients (Burt & Barber, 1996) were calculated for all continuous variables, with and without controlling for the restrictiveness of zone type². Results are reported in Tables 4.6 and 4.7.

² The zoning for each parcel was ranked according to the restrictiveness of permitted uses in that zone type, i.e., fringe areas are assumed to be least restrictive, while forest and conservation reserves most restrictive, and estate/suburban residential falling in between.

Table 4.6. Pearson's Correlation Coefficients, 1 = Raw; 2 = Controlling for Zone Type*

	Parcel Size	Percent Slope > 12	Income	Dist. to Bloomington	Dist. to Ellettsville	Dist. to I-37	Dist. to I-46	LPI_F	IJI_L
1. Parcel Size	1.00								
2. Parcel Size	1.00								
1. Percent Slope > 12	-0.1034	1.00							
2. Percent Slope > 12	-0.0860	1.00							
1. Income	-0.0328	0.1005	1.00						
2. Income	-0.0317	0.1247	1.00						
1. Dist. to Bloomington	-0.2296	0.0744	0.0652	1.00					
2. Dist. to Bloomington	-0.2255	0.1657	0.0608	1.00					
1. Dist. to Ellettsville	-0.0067	0.3833	-0.0250	-0.0502	1.00				
2. Dist. to Ellettsville	-0.0438	0.2672	-0.0113	-0.0303	1.00				
1. Dist. to I-37	0.2035	-0.0449	-0.0617	-0.0858	0.2144	1.00			
2. Dist. to I-37	0.1101	-0.0866	-0.0568	-0.0019	0.1853	1.00			
1. Dist. to I-46	-0.0260	-0.0395	0.0509	0.0426	0.1420	-0.1148	1.00		
2. Dist. to I-46	-0.0194	-0.1987	0.0614	0.0403	0.0981	-0.1180	1.00		
1. LPI_F	-0.0097	0.6032	0.0810	0.0617	0.3219	0.0698	-0.0280	1.00	
2. LPI_F	-0.0061	0.5290	0.1030	0.0934	0.1716	-0.0347	-0.1559	1.00	
1. IJI_L	-0.0629	-0.3686	-0.0734	-0.0123	-0.2432	-0.0641	-0.1651	-0.4360	1.00
2. IJI_L	-0.0700	-0.3049	-0.0932	-0.0377	-0.1439	0.0114	-0.0716	-0.3147	1.00

*Values significant at the 95% level are in bold.

	Raw	Controlling for Zone Type
Correl(Slope, Dist. to Ellettsville)	0.383	0.2672
Correl(Slope, LPI_F)	0.6032	0.5290
Correl(Dist. to Ellettsville, LPI_F)	0.3219	0.1716
t-statistic	2.78	3.10
Correl(Slope, IJI_L)	-0.3686	-0.3049
Correl(Dist. to Ellettsville, IJI_L)	-0.2432	-0.1439
t-statistic	-1.19	-1.57

Table 4.7. Hotelling's Test of the Equality of Dependent Correlation Coefficients
Note that values significantly different at the 95% level (one-tailed t-test) in bold.

Several of the variables were significantly correlated with the two indices of fragmentation, LPI_F and IJI_L. LPI_F was higher at greater slopes and farther from Ellettsville, and IJI_L was lower. Parcels located on flatter areas closer to the city center were more fragmented and possessed fewer, more concentrated patches of forest cover. These findings did not change when the effect of zoning was controlled for, though the magnitude of each effect was diminished. The two indices were significantly negatively correlated with each other (the higher the interspersation of land cover types, the lower the concentration of forest cover).

Some variables were also significantly correlated with each other. In particular, the percentage of steep slopes was strongly correlated with the distance to Ellettsville city center. Parcels also tended to be bigger closer to Bloomington and further from I-37, the main north-south highway leading to Indianapolis. Because both steep slopes and distance to Ellettsville were correlated with both our fragmentation indices, the qualitative rank of their effect with and without controlling for zoning was calculated.

We follow the work of Dunn and Clark (1971) who provided a detailed analysis of four statistics designed to test for the equality of correlation coefficients when these

coefficients themselves are correlated. In other words, we wanted to measure the magnitude of the effect on our fragmentation indices of slope and distance to Ellettsville, given that the two former variables are significantly correlated. The test statistic we chose is Hotelling's (1940) statistic:

$$t = (r_{12} - r_{13}) \left[\frac{(n-3)(1+r_{23})}{2D_3} \right]^{1/2}, \quad (4.4)$$

where r_{12} and r_{13} are the correlations between one variable (1) and two other variables (2 and 3), r_{23} is the correlation between them, and D_3 is the determinant of the sample correlation matrix. The null hypothesis is that these two correlations are equal, or slope and distance to Ellettsville are equally important, whereas the alternative hypothesis is that one is greater than the other. Table 4.7 presents the result of this analysis. The correlations between slope and LPI_F and IJI_L as well as distance to Ellettsville and LPI_F and IJI_L were tested with and without controlling for zoning.

All three factors, slope, distance to Ellettsville, and both indicators of fragmentation, were significantly correlated, but all correlations were weaker once one controls for the restrictiveness of zoning. For example, the correlation between the degree of slope and LPI_F is 0.60 raw, and it is 0.52 after controlling for zoning. Once one controls for zoning, the correlation between LPI_F and both slope and distance to Ellettsville decreases, but it decreases to a much greater extent for the latter. In other words, the effect of slope seems relatively stronger after controlling for zoning. Similar results occur in comparing the relationship between IJI_L and both slope and distance to Ellettsville, but these results are not statistically significant. This finding implies that one cannot reject the null hypothesis that the impact of either slope or distance Ellettsville are equal, with or without controlling for zoning. Therefore, we can conclude that

topographical and socioeconomic variables are significantly related to the extent and distribution of landscape pattern in Monroe County, Indiana, and that the impact of both factors is mediated by zoning restrictions on individual, rural and suburban parcels. We also find that slope is qualitatively more strongly correlated with the concentration of forest patches relative to market accessibility, but for overall landscape patch interspersions, there is no significant difference between the two factors.

4.5 Policy Relevance and Directions for Future Research

The northwestern portion of Monroe County is facing some opposing land use pressures because development is encouraged close to Ellettsville's infrastructure, but the area also is relatively good agricultural land. Because the topography of this area is relatively flat, slope plays less of a role, so zoning policy may be more important. The portion of the county that lies west of Bloomington and near State Highway 37 has experienced unprecedented urban development in the last decade, as the city sought to alleviate depressed economic conditions. However, improvements in infrastructure have not kept up with growth. Relatively unrestricted growth in this region of the county may be associated with the relatively high measures of forest fragmentation, and therefore it should be of concern to planners. The results indicate that the other measure of configuration, landscape interspersions/juxtaposition, is relatively high in the fringe area surrounding Bloomington. Although this finding is not robust to a simple measure of distance to Bloomington city center, it indicates that the urban fringe area around Bloomington is the most likely place for negative externalities to develop which may need to be addressed through zoning policies. It also suggests that zoning policy in this region is relatively more important than distance to the city, and therefore the relative

laxness of the “Fringe” designation, in the area right outside the Bloomington city limits, may not be socially optimal. In general, the results indicate that zoning policies have a greater impact on landscape and forest fragmentation in some areas of the county than other areas, i.e., in those areas where both the cost of development due to topography is lowest *and* development pressures (in terms of city access) are highest, as in areas near Ellettsville.

Many planners have advocated the consolidation of planning power at the state level. It may be effective to establish multiple layers of regulation that deal with large ecological or topographic features stretching across political boundaries. However, this study indicates that fine-scale, parcel level characteristics may also play an important role in the success of zoning policy. Perhaps, a polycentric political structure that incorporates several levels including federal, state, and local policymakers may solve more of the problems associated with urbanization than approaches that focus on any one particular level exclusively.

Academic research into this issue could inform policy, particularly in a peri-urban region, before a dire amount of landscape fragmentation has occurred. However, there are complicated relationships between parcel characteristics, zoning, and landscape fragmentation, which indicates that planners should be especially careful in evaluating the interrelationships among these factors when making an assessment of the effectiveness of planning and zoning policies. This initial study illustrates the complexity in a simple analysis and demonstrates the need for further work examining other complicating factors such as larger regional effects from major metropolitan regions, and the effectiveness of implementing policies over larger biogeophysical areas.

4.6 Conclusion

We have found that zoning's impact on fragmentation is mitigated by biogeophysical factors. In areas of high development pressure, there is great potential for zoning to regulate growth, although in the case of Monroe County we find that lax zoning has lead to fragmentation in a high pressure area. Zoning impact on land use management is a result of the rules and context, as we have demonstrated in this case, but also is a result of enforcement. In the next chapter, we explore citizen monitoring of zoning, which is especially important given the inspector's difficult task of monitoring large regions. As we discussed in the Chapter 2, there are many instances of development occurring without the required variances or rezoning. Thus, there is potential for development to occur because of lack of official capacity for enforcement. Citizens provide inspectors with information about potential violations varying from junk cars left in an urban front yard to development of an exurban property.

Chapter 5: Citizen Reporting and Zoning

By Abigail M. York¹

As discussed in the previous chapter, some zoning rules appear to have an impact on parcel level land use management. The impact of zoning on individual landowner behavior results from the actual rules, as well as the enforcement of these rules. In this chapter, I explore how zoning enforcement is related to citizen monitoring through a game theoretic analysis of the interactions of neighbors, citizens, and zoning inspectors. The general games were developed in conjunction with Becky Nesbit to generally explore the zoning enforcement arena. In our general analysis, Nesbit and I found that zoning compliance depended on the reporting costs and consist fining of violations. In this chapter, I expand this analysis in order to address how the innovation of online searchable parcel level zoning ordinance databases alters the basic zoning enforcement game.

It is important to understand how online information impacts the game, as many county governments throughout the country have been going online. Some of these websites provide phone numbers and contact information, but a few sites provide citizens with extensive information. Some websites focus on plan creation and visions, while others seek to promote development opportunities in the area. A subset of these government websites provide information about zoning laws. This chapter explores how this online information alters citizen monitoring in the zoning and planning game. I discuss the state of online zoning in Indiana, as well as provide some exemplary examples from other jurisdictions in the US.

¹ This chapter draws on work coauthored with Becky Nesbit, "The Neighborhood Game," presented at the Urban Affairs Conference, Washington, DC, March 31-April 2, 2004. Becky Nesbit was instrumental in the development of the games.

E-governance has been touted as a means to improve public service provision at all levels of government and for all types of services (Brown and Brudney, 1998). Local governments increasingly are providing Geographic Information Systems (GIS) to citizens on their websites. GIS enables the government to share spatially explicit information such as school district boundaries, park locations, crime data, and zoning ordinances. GIS may be a means to improve citizens' ability to monitor illegal behavior, such as zoning ordinance violations, vandalism, and other types of crime.

Many laws rely on citizen monitoring and reporting in order to be effective. For example, initiatives to stop drunk driving encourage citizens to call emergency personnel when observing erratic driving. Other laws, such as violation of environmental regulations, are difficult for inspectors to monitor, so enforcement depends heavily on neighbor complaints. Whitaker (1980) argues that citizen coproduction of local ordinances is essential for compliance through reporting of violations to local authorities. As citizens serve as watchdogs, they may be more invested in the law, so possibly likely to violate themselves, or at least the additional citizen policing may increase the risk for those already violating.

In order to report violations and obey zoning laws, citizens must be aware of local ordinances. Zoning ordinances can be particularly confusing because zones may be fairly localized and parcels are commonly subject to variances, which alter the allowable uses. Thus, citizens may be unaware of the zoning rules on a neighbor's property. Online Geographic Information Systems (GIS) that allow citizens to access information about zones on specific parcels improve the citizens' ability to accurately report a zoning

violation. Furthermore, citizens will be less likely to inadvertently violate an ordinance if it is easier for them to check the zoning rules for their own parcel.

Given scarce resources in many areas of law enforcement, citizen reporting can be essential for compliance. In one example from private government, Weissing and Ostrom (1991) argue that citizen irrigation monitors will report others if there is a probability of violation and if the cost of monitoring is relatively low. Nesbit and I extended their analysis to a different resource problem where a citizen may report another's violation of land use laws to a government inspector. The typical neighborhood is an interesting place to investigate citizen willingness to monitor others, as well as the ability of zoning to reduce nuisances. The common suburban or peri-urban neighborhood is the environment that Putnam (2000) observed as a place of relative seclusion and limited interaction, which may indicate unwillingness of neighbors to informally deal with nuisance causing neighbors. Rather neighbors may opt to contact an official zoning inspector instead of confronting an unfamiliar neighbor. GIS technology may be an important innovation an important technological innovation in enforcement of zoning laws because these laws cover specific spatially explicit areas within a community.

In the next section, I briefly describe the neighborhood environment and zoning in the United States. Then I describe different types of GIS applications in the zoning arena, which may impact enforcement. This is followed by a game theoretic analysis of the zoning arena prior to GIS technology and with GIS. The game theoretic analysis examines the costs and benefits to the three main players in this game: the potential violator, the reporter, and the inspector. I conclude with a discussion of the impact of

GIS on the zoning arena providing some policy recommendations and directions for further research.

5.1 The Neighborhood and Zoning

Neighborhoods throughout the world are full of examples of neighboring landowners annoying each other through inconsiderate actions, as well as landowners that continually lend a helping hand to each other. Neighbor fights frequently result from disagreements over negative externalities generated by private land uses, such as trees that leave debris on a neighbor's land or obnoxious smells or noises, like the pigsty in the classic *Aldred's Case* (Dukeminier and Krier, 2002). Many contentious battles have also been fought over adverse possession of neighboring land, like in *Mannillo v. Gorski* (1969) where a neighbor claimed a few inches or in *Van Valkenburgh v. Lutz* (1952) where an entire parcel was adversely possessed (Dukeminier and Krier, 2002). Neighborhoods across the country contain stories of relationships that have soured over land use.

As I discussed in Chapter 2, zoning in the United States was created in the 1920s in order to reduce externalities associated with noncompatible neighboring land use and reduce these neighborhood battles (Revell, 1999). Early zoning sought to separate incompatible uses through zones for residential, commercial, and manufacturing uses. Modern zoning often includes mixed-use zones, which integrate residential, commercial, and light manufacturing. Environmental regulations, such as installation of runoff barriers during home construction, are now included in zoning codes (e.g. Monroe County Plan Commission, 1995). Zoning codes are a mechanism to reduce nuisances, but are only effective if the laws are enforced and followed.

Zoning ordinances often include restrictions that are difficult to monitor on private property, such as limits on numbers of nonfunctioning automobiles, length of grass on lawns, or restrictions on home businesses. Inspectors driving by a property may not notice the violation, especially those that are not permanent, unless they pass by at the time that a violation occurs. Furthermore, some violations may not be easy to identify during a drive-by inspection. In Chapter 2, I discussed how enforcement of zoning occurs through zoning inspection and fines, injunctions, and sometimes lawsuits against violators. Inspectors typically cover large land areas. The inspector may be both a building code and zoning inspector, which may lead to inexperience with zoning codes or building code inspection and enforcement taking priority over zoning enforcement. Thus, inspectors are asked to cover a large land area with many different responsibilities.

Inspectors are required to enforce the zoning ordinances, but typically do not have the resources to effectively police the entire jurisdiction. Given the scarce resources inspections often come as a result of citizen complaints, so compliance success is often related to neighborly policing and issues of citizen concern. Ellickson and Been (2000) note that inspection is often left to building departments while may not have sufficient knowledge of zoning ordinances, which leads to a principal-agent problem between the building department inspectors and the planning department. Monitoring the inspector's behavior is similar to the classic dilemma in bureaucratic management where the elected officials, principal, have limited ability to monitor the bureaucracy, agent (Weimer and Vining 1999, and Wintrobe 1997), as well as the challenges in the private sector, where an employer, principal who has limited knowledge, skill, or resources to monitor to the employee, agent (Miller 1994). The building inspectors' job security is tied to their

enforcement of the building code, so we may expect that there is limited incentive for the inspectors to enforce the zoning codes, creating the principal-agent problem that was discussed in Chapter 2. This problem is exacerbated by limited planning department control over building inspectors' work assignments and job performance rating.

Professional zoning inspectors under the direction of the planning department may know and understand the zoning laws, but have their own priorities with respect to enforcement. In a conversation with a zoning inspector in Monroe County, Ind. he indicated that each inspector has a priority, such as run-off control or elimination of junk cars on front lawns. These priorities focus the inspectors' activities, but not all plan components and zoning ordinances may be a priority, as we discussed in Chapter 2. Therefore, if non-conforming landowners recognize that no one cares about compliance with a particular ordinance, the owner may continue the illegal use with limited fear of getting caught or fined. In some communities with junk car ordinances, violators are not a priority, so cars pile up in yards, while in more affluent communities junk cars will be removed quickly in order to prevent an "eyesore."

Zoning relies on neighbor complaints to aid in enforcement and compliance. Neighbors may be more willing to report illegal land use that they find offensive. If two neighbors have a history of disagreement, one may be more willing to report a minor offense to authorities. In comparison, neighbors with friendly relations may be willing to overlook each other's violations. Thus uneven zoning code enforcement is typical within a jurisdiction (Babcock and Siemon, 1985, Rudel, 1989). Certain types of communities may be prone to informal land use agreements outside of zoning code enforcement. Rudel (1989) argues that residents of rural communities frequently create informal

agreements concerning land use. On the other hand long time neighbors also have the potential for long-term feuds over land use. Homeowners are often more motivated and informed about local land use than renters, so areas with high homeownership may experience more neighbors policing of zoning code violations (Rudel, 1989, Ellickson and Been 2000).

In the urban-rural fringe exurbanite residents and rural natives create a hotbed of land use conflict, as many exurbanites are willing to call the authorities prior to talking with their rural neighbors about offensive land use (Rudel, 1989). In particular, long time rural residents may have limited exposure to and experience with zoning code enforcement, so may be unaware or unconcerned with going through the rezoning or variance process. New rural residents may perceive nuisances from existing rural residents, such as farmers, from commonplace agricultural activities such as spreading manure, spraying fields with pesticides, or creation of noxious odors in lagoons or animal barns. These conflicts can lead to attempts to change or adopt zoning codes that restrict agricultural practices, although many states Right to Farm Acts limit local enforcement of laws perceived as anti-agricultural.

Given the challenges that local governments face enforcing particular zoning laws, the zoning ordinances and comprehensive plan ideals are only as good as the monitoring and sanctioning associated with it. If residents do not witness credible land use policing, we may expect that there will be widespread noncompliance. Many jurisdictions do not have the resources to effectively monitor land use regulations violations. Throughout the country, governments rely on citizen complaints to enforce the zoning ordinances (Ellickson and Been 2000). Therefore, land use regulatory

enforcement probably will be concentrated in the most visible types of violations. The problem with citizen enforcement is that it only works if citizens are willing to take the time to be aware of legal uses under the zoning ordinances, to watch their fellow citizens' use, and report the offense. Thus, many citizens are willing to free ride on others policing, so there is the typical collective action problem associated with citizen lead enforcement.

On the other hand, in some jurisdictions there have been instances where noncompliance has lead to costly fines or injunctions, where the landowner was required to tear down a building or to remodel it to fit the zoning ordinance. As we discussed earlier, in one case in New York, an apartment developer was required to remove twelve stories of thirty-one story complex to conform to the ordinance, as an expense of \$2 million (Ellickson and Been 2000). Variances are sometimes granted for landowners that experience a hardship due to the regulation, although frequently self-created hardships do not qualify for a variance (Ellickson and Been, 2000). In order for land use regulation to be effective the *de jure* rules must match the *de facto*. There must be a credible threat of enforcement of the rules in order for the land use regulation to be effective.

This chapter identifies the strategic activities of neighbors and inspectors in the land use arena in order to understand under what conditions landowners will comply with zoning codes. The importance of this chapter is that it outlines conditions where zoning violations will be rampant and where neighbor reporting and inspection will lead to compliance. I explore how GIS technology affects the land use policy enforcement arena through lower cost access to information. In the next section, I describe the increased use

of GIS in the zoning arena throughout the country. Then I explore the use of GIS within southern Indiana.

5.2 GIS and Zoning

GIS has been used by small towns, cities, and counties throughout the country to store information about zoning codes and variances, as well as property tax information (Brown and Brudney, 1998). These communities often seek to improve communication with citizens, as well as potential developers. Many of these communities post some of the GIS information online, allowing citizens to access zoning codes and variance information. In this section I explore several exemplary examples of online GIS technology used by three different cities. Then I focus my attention on southern Indiana county government's use of online GIS technology, in order to provide context for this analysis. Information was obtained through an online search of city and county websites.

5.2.1 Three Stellar Examples of Online GIS Adoption

In Reno, Nevada, the city allows access to zoning ordinances, as well zoning maps and comprehensive plans (City of Reno, 2004). The city has automated zoning code enforcement by allowing citizens to view existing complaints on properties within the city (City of Reno, 2004). GIS allows citizens to determine the zoning ordinances that apply to neighboring properties, while the interactive complaint website provides another convenient means to contact inspectors. The website also provides contact information for the inspector's office, if citizens prefer to contact an official directly.

In Bloomington, Indiana, the mid-size city home to Indiana University, the city has posted general information regarding zoning codes, but does not allow searches for particular parcels. The website includes large scale zoning maps, but no means to check

specific parcels (City of Bloomington, 2004). Currently there is not a means for citizens to electronically report or check on complaints. The city does provide extensive information about the zoning ordinances and permitting. Thus, citizens may access information about the code online, but it would be difficult to determine whether these codes applied to particular parcels.

On the other hand, the City of Chicago provides extensive GIS information to citizens through its website <http://w27.cityofchicago.org/website/zoning/index.html>. Similar to Reno, Chicago provides parcel level zoning information, as well as contact information for zoning concerns. Unlike Reno, Chicago does not allow citizens to electronically file zoning complaints. Thus, Chicago represents a middle ground between Bloomington and Reno with individual parcel information, but limited access options. There are several problems with Chicago's interactive map, especially the limited information updates and computer requirements to upload information. The map was last updated in February 2004², so may not have accurate information about current building projects making it difficult for citizens to report violations occurring in construction areas (City of Chicago, 2004). For zoning ordinances regarding general property upkeep, this delay in information relay to the public website may not be important, but in areas experiencing extensive development this delay reduces the ability of citizens to access information about the parcel and file complaints. The quality of information on Chicago's map is exceptional and detailed, which is impressive given the large scale of their GIS project.

There are many cities that have not invested in GIS technology because of the high costs to implement and maintain the database (Brown and Brudney, 1998). The

² The website was last checked on August 10, 2004.

three examples provided illustrate different levels of zoning GIS information from general maps in Bloomington, interactive maps in Chicago, and ability to check complaints in Reno. Many cities and counties still do not have up-to-date websites, let alone interactive zoning maps. In Indiana, there are many local governments with only one copy of a comprehensive plan³, so Bloomington, Ind. city government provides much more information to residents than most Indiana cities.

5.2.2 County Use of Online GIS Technology in Southern Indiana

In southern Indiana, the majority of counties with planning and zoning ordinances do have an online presence, but this is typically a listing of phone number and official names. I evaluated the each county's online presence through extensive internet searches for each county's site. As can be seen in Table 5.1, only 7% of the counties put their comprehensive plan on the department or county government website. Interestingly, 18% of counties put the zoning ordinance, or at least portions of the ordinance, online. This may enable citizens to better understand what is typically allowed in residential, mixed-use, commercial, industrial, or other types of zones, although citizens are unable to access information about their neighbor's zone online. Only two counties have land use maps online. One county has maps at a township level, so it is difficult to determine parcel boundaries in order to assess whether a neighbor is in violation. Monroe County, home to Bloomington, Indiana, has similar information as the City of Bloomington, but also includes, a searchable online database, which enables landowners to quickly access information about potential violators.

³ This information was obtained when trying to gather comprehensive plans for analysis. Several counties reported that the plan could not be copied or evaluated because there was only one copy. Jamie Palmer of the Center for Urban Policy and the Environment, Indianapolis, Ind. reported that this was commonplace in small Indiana cities as well.

	Count	Percentage of Counties in Study Area	Percentage of Counties with Planning
Total Counties	40	100%	
County level Planning	28	70%	100%
Website	15	38%	54%
Plan on Website	2	5%	7%
Zoning Ordinance on Website	5	13%	18%
Land Use Maps on Website	2	5%	7%
Searchable Maps on Website	1	3%	4%

Table 5.1. County Planning Technology

The ability of online GIS to be an effective technology depends on the abilities and internet access of citizens (Brown and Brudney, 1998). Thus, in rural Indiana, online GIS may not be an option to improve zoning enforcement and compliance because of limited community access to the internet. Whereas in relatively cosmopolitan locations, such as Chicago and Reno, citizens may prefer to access government information online because of time constraints and difficulty contacting bureaucrats via phone or in person. Within southern Indiana, it appears that online technology is increasingly used to provide citizens information, although most citizens will still need to make a potentially time consuming phone call to the county offices in order to determine whether to file a complaint. In the following section, I explore the impact of online GIS information on zoning enforcement and compliance through citizen reporting. As more southern Indiana counties adopt this technology the game will become more common, although at this point in time only two counties have zoning maps online. In the next section, I describe the general game that Nesbit and I developed to investigate citizen reporting of zoning violations.

5.3 General Game

Within Nesbit and York's generalized neighborhood zoning game there are three main players in the violator/neighbor game: the violator, the neighbor, and the inspector.

The violator is the first player to move in the game because a violator's action will determine if a citizen makes a complaint. The violator lives in close proximity to the neighbor. We assume that the neighbor can easily observe violations taking place on the violator's property. The violator wants to use his property in some way that is inconsistent with zoning laws. As discussed in Chapter 2, there are many types of property rights restrictions in zoning codes addressing aesthetics, environmental and health concerns, impact on public infrastructure, and traffic patterns. The violator wants to violate zoning restrictions because it will either bring him benefit, through aesthetic pleasure or additional revenue, or reduce his costs, for clean-up or prevention of runoff. In this simple game the violator initially has two choices, either to do nothing or to violate the zoning law.

If the violator chooses to violate, this action has negative externalities for the neighbor, the second player. The nature of these externalities can be a decrease in property values or health concerns from illegal runoff, annoyance at all the junk cars parked on the lawn, or increased traffic from an illegal home business. With GIS technology it is less likely that a violator will unintentionally violate a zoning ordinance because parcel level rules are easily available.

After observing the action of the violator, the neighbor has two possible actions to take, he can either do nothing or report the violation to the zoning inspector. If the neighbor chooses to report the violation, there are costs for reporting such as gathering information about whether there neighbor has actually violated, making a phone call to a zoning inspector, as well as possible repercussions from the violator, such as a decrease in neighborly relations. Again with online GIS technology, the reporting cost for the

neighbor is lower because it is easier to determine if a complaint will result in fine. Instead of several phone calls and possible trips to the planning department, the neighbor can quickly determine whether the violator has violated the zoning code with an online GIS searchable parcel level database. With this sort of technology, the neighbor can use go to a website with a map of the parcels in the county. The neighbor then enters the address of the violator and may determine the zoning laws and variances that apply to the parcel. As I discussed in the case of Reno, with online technology, the neighbor may also be able to file a complaint online without ever having to play phone tag with an inspector.

The final player in this game is the zoning inspector who begins to act after receipt of a citizen complaint about a zoning violation. The inspector can either ignore the complaint, doing nothing, or inspect the violation. We assume that when the inspector goes out to inspect the violation that he or she will impose some kind of fine on the violator, in order to simplify the game.

5.3.1 Game Payoffs

The neighbor begins with a certain property value, listed as P_N (Table 5.2). If the violator does not violate the zoning regulations, then the neighbor's property value remains the same. If the violator does violate zoning, then the neighbor's property value decreases by the amount γ . If the neighbor decides to report the zoning violation to the city, the neighbor incurs a reporting cost, C_R , which includes an information gathering cost. This cost can just be the hassle of reporting the violation, or more tangible costs like driving to the local planning or building department to talk with the zoning inspector or the inspector's supervisor. Again, I expect that this cost will be lower if there is GIS

technology because the neighbor can more easily determine whether there was a zoning code violation by the violator.

Symbol	Description
P_N	Neighbor's property value
γ	Cost of violation to neighbor
C_R	Neighbor's cost of reporting violation
P_V	Violator's property value
B	Value of violation to violator
F	Fine imposed on violator for zoning violation
C_F	Inspector's cost of inspecting when giving a fine
C_H	Inspector's hassle cost when choosing to do nothing
W	Inspector's payment for inspecting

Table 5.2. Game Payoff Parameters

The violator also begins with a certain property value, P_V . We assume that the violator also derives some benefit from the violation, and this is represented as β . This benefit, for example, may come in the form of income from an at home business or a cost reduction during building construction for failure to use runoff barriers. The violator also faces a cost when the inspector inspects the property and gives a fine, say F .

The inspector is salaried, so does not receive any compensation for an increase in the number of inspections that he makes. No matter which strategy the inspector chooses, to inspect or not, he will receive his payment of W . If the inspector does not go to inspect the violation, then the inspector will incur a cost for not inspecting, say C_H . This cost can be incurred through the citizen complaining or receiving a reprimand from a supervisor. There is also a cost associated with going to inspect the violation because

inspections are not necessarily easy, as inspections take time to drive out to the violator's property and inspect the violation. If the violator is belligerent and confrontational, then this cost is even higher. The cost of doing the inspection and giving a fine is C_F .

5.2.2 One Shot Zoning Game

The basic Nesbit and York games are a one-shot zoning game with the violator, neighbor and inspector as the three players and same zoning game with a longer time horizon. In this chapter, I add to our previous analysis a lower reporting and information gathering cost for the neighbor with the addition of GIS technology in the jurisdiction.

As in our general game, players move sequentially, so we present the game first in extended form. Figure 5.1 depicts the neighbor/violator/inspector zoning game.

The first player to move is the violator. The violator decides whether or not to violate the zoning regulations. If the violator decides not to violate the zoning laws, then the game ends. In this instance, both the violator and the neighbor received payoffs equal to their property values and the inspector receives a payoff equal to his salary.

If the violator does decide to violate the zoning laws, then the neighbor has an opportunity to move. The neighbor can either report the violation or choose not to report it. If the neighbor does not report the violation, then the game ends, with the neighbor receiving a payoff of a decreased property value and the violator receiving increased payoffs from the violation. In this instance, the inspector will again receive a payoff consisting of his salary.

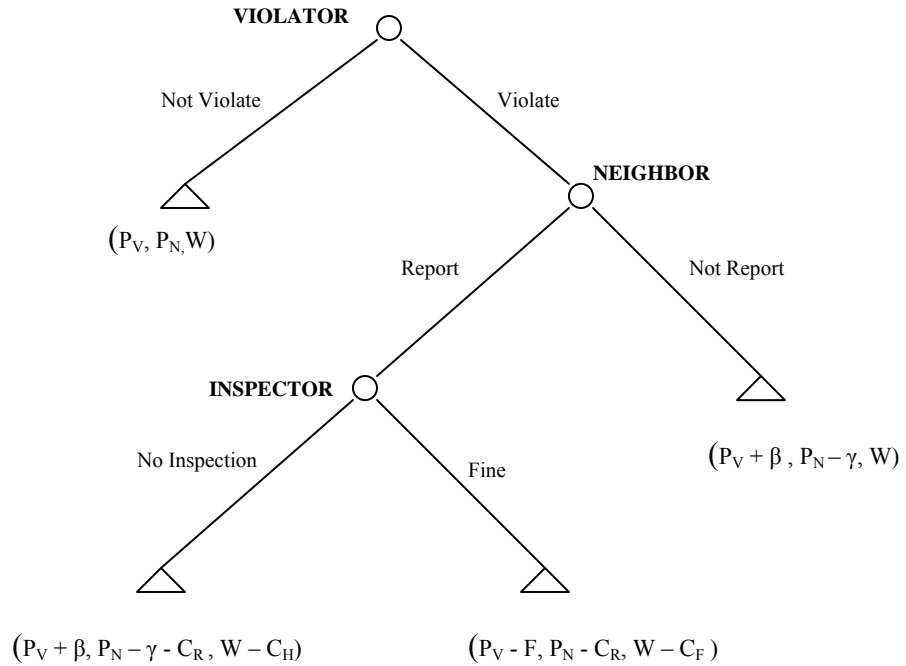


Figure 5.1. Neighbor/Violator/Inspector Zoning Game, Extended Form

If the neighbor reports the violation, then it is the inspector's turn to move. There are two alternatives. The inspector can either choose not to inspect the violation or to inspect the property and fine the violator. If the inspector chooses not to inspect the violation, then the inspector receives a payoff equal to the wage, W , minus the hassle cost, or C_H . The hassle cost is the cost to the inspector of dealing with a citizen complaint, such as listening to that person on the phone or setting aside time to have a audience with him. And if the inspector goes and gives a fine, then he receives $W - C_F$, where C_F is the cost to the inspector of giving a fine to the violator. This cost is incurred just by the time and effort it takes to go inspect the violation along with possible harassment from the violator.

Solving the tree backwards, we look first at the inspector's choices. The choice about whether or not to inspect and what kind of sanction to impose is based mainly on what costs the three options present to the inspector.

5.3.2.1 Case 1: Low Cost of Doing Nothing

Suppose that the lowest of the two cost parameters is the hassle cost, or the cost of doing nothing, C_H . This would mean that doing the inspection would take just too much time and energy and that the inspector expects a difficult visit. In this case, the inspector will choose to do nothing because that option gives him the highest payoff. If the inspector chooses to do nothing, then the neighbor will choose not to report the violation because the cost of reporting will just add to the neighbor's losses. And since the violator knows that the neighbor will not report the violation, his optimal strategy is to violate. Therefore, the equilibrium in this case will be (violate, not report, do nothing).

5.3.2.2 Case 2: Low Cost of Fining

If the cost of fining the violator for the violation is the lower cost to the inspector, then the inspector will choose to fine. This could happen when the inspector knows that there will be a lot of trouble and hassle for not doing the inspection. There could also be a lot of hassle if a warning is given instead of a fine and the violation isn't stopped. This could bring more complaints and problems. If the inspector fines the violator, then the neighbor is faced with a choice. If the cost of reporting is greater than the decrease in property value from the violation, then the neighbor will choose not to report the violation because his payoffs will decrease. And in that case, the violator will choose to violate and the equilibrium is (violate, not report, fine).

5.3.2.3 Case 3: Low Cost of Reporting

If the cost of reporting is smaller than the property value decrease, then the neighbor will choose to report the violation. If the neighbor reports the violation, then the violator's best strategy is to not violate the zoning rules in the first place. In this instance, the equilibrium will be (not violate, report, fine). Thus with online GIS technology, where I expect that the reporting costs are low for neighbors, there should be an equilibrium strategy of zoning code compliance. This equilibrium depends upon the property value decrease, if the particular violation is of limited concern to the neighbor, even with a low reporting cost, we should not expect reporting or compliance. The only equilibrium where the violator's dominant strategy is not to violate the zoning rules happens when the inspector's cost structure makes fining profitable and when the cost of reporting is small enough to induce the neighbor to report the violation. Thus, we should expect that there are many instances of zoning code violation in the real world.

5.3.3 Multiple Neighbor Game

Nesbit and I also extend game two to allow for more neighbors in order to make the zoning game more realistic. Solving the extended game is not nearly as simple as solving the previous game. In this instance, the inspector's decision whether or not to inspect depends on the decision of both of the neighbors. For purposes of ease, we will assume that the neighbors are symmetrical, meaning that their costs and payoffs are the same. In future analysis, we will examine the case of asymmetric neighbors.

The inspector's decision of whether or not to inspect the zoning violation depends on the relative costs of doing nothing, C_H , and the cost of inspecting, C_F . If the cost of doing nothing is less than the cost of inspecting, then the inspector will always choose to

do nothing. If the cost of inspecting is less than the cost of doing nothing, then the inspector will always inspect the violation and fine the violator. However, there is another important case to consider. Remember that the cost of doing nothing, C_H , represents a hassle cost to the inspector of dealing with the complaining citizen. When more than one citizen complains, we assume that this cost is doubled. The third interesting case is when $C_H < C_F$, but $C_F < 2C_H$. In this instance, the inspector will not inspect if only one neighbor complains, but will inspect if more than one neighbor complains. Thus there may be a collective action problem in generating enough complaining neighbors in order to induce a inspector to actually check out a potential violation.

Case 1: $C_F > C_H$, Inspector Never Inspects		
	Decision of Violator	
Decisions of Neighbors	<i>Violate</i>	<i>Not Violate</i>
<i>Neighbor 1 Reports</i>	$P_N - \gamma - C_R$	$P_N - C_R$
<i>Both Neighbors Report</i>	$P_N - \gamma - C_R$	P_N
<i>Neither Neighbor Reports</i>	$P_N - \gamma$	P_N
<i>Neighbor 2 Reports</i>	$P_N - \gamma$	P_N
Case 2: $C_F < C_H$, Inspector Always Inspects		
	Decision of Violator	
Decisions of Neighbors	<i>Violate</i>	<i>Not Violate</i>
<i>Neighbor 1 Reports</i>	$P_N - C_R$	$P_N - C_R$
<i>Both Neighbors Report</i>	$P_N - C_R$	P_N
<i>Neither Neighbor Reports</i>	$P_N - \gamma$	P_N
<i>Neighbor 2 Reports</i>	P_N	P_N
Case 3: $C_F < C_H < 2 C_F$, Inspector Inspects When More Than One Neighbor Reports		
	Decision of Violator	
Decisions of Neighbors	<i>Violate</i>	<i>Not Violate</i>
<i>Neighbor 1 Reports</i>	$P_N - \gamma - C_R$	$P_N - C_R$
<i>Both Neighbors Report</i>	$P_N - C_R$	P_N
<i>Neither Neighbor Reports</i>	$P_N - \gamma$	P_N
<i>Neighbor 2 Reports</i>	$P_N - \gamma$	P_N

Table 5.3. Payoffs to Neighbor 1 in Extended Zoning Game, Inspector as Player

As seen in Table 5.3, in Case 1 when the inspector never inspects the violation, then Neighbor 1's best response is never to report the zoning violation because it will never be

inspected. In this instance, the violator will always choose to violate the zoning regulations.

In Case 2, then Neighbor 1's best response to a zoning violation depends on the relationship between the costs of reporting, C_R , and the cost of the violation to the Neighbor, or γ . If the cost of reporting is relatively small, then the neighbor should report the violation. If the cost of reporting is relatively large, then the neighbor is better off not reporting the violation. Even if the cost of reporting is small, the neighbor is better off not reporting the violation if the probability that another neighbor will report it is very high. In this case the neighbor receives all the benefit of having the violation reported and fined without bearing any of the costs of such an action, presenting a classic free-rider problem.

And finally, Case 3 is even more complicated. In this case, the neighbor's best response to a zoning violation depends very heavily on the probability of another neighbor also reporting the violation and the relative cost of reporting compared to the cost of the violation. If the probability of another neighbor reporting the violation is small, then the neighbor should not report the violation because only if both neighbors report will the inspector choose to inspect the violation. If this probability is high, however, then the neighbor should report the violation only if the cost of reporting is smaller than the cost of the violation to the neighbor. Thus with online GIS technology we may expect an increase in reporting through a reduction in the reporting costs. We may especially expect this in cases such as Reno with its online compliant filing option. In all cases, whenever the violator chooses not to violate, then the neighbor's best response is not to report the violation.

In summary, this extended game illustrates the importance of several sets of costs. First of all, the relative costs to the inspector of doing nothing and inspecting the violation are important determinants in the inspector's decision. The relative cost of reporting and the cost of the violation to the neighbor are important in determining whether or not the neighbor should report the violation. And this game also shows that the probability of another neighbor reporting the violation can also be a pivotal parameter in the neighbor's decision of whether or not to report the violation. Thus, in neighborhoods where neighbors talk, we might expect some coordination of reporting that overcomes the free-ride problem.

5.3.4 Repeated Zoning Violation Game

To better approximate the zoning game, we will now look at the zoning game as a game with a longer time horizon. In the real world, violators are often repeat offenders, especially if the violation is due to something like runoff or junk cars. In this game, the inspector is again modeled as a third player who receives payoffs from the different outcomes of the game. The big difference between this game and game two is that in this game the inspector's actions do not end the game. For example, if the inspector does not inspect the violation, the neighbor can repeatedly call in to report the violation. And if the inspector does go to inspect the violation and give a fine, the violator would not necessarily cease the violation. In this way, this game is the more realistic than the previous games. The payoffs associated with each of these end notes is shown in Table 5.4.

Node	Violator (V)	Neighbor (N)	Inspector (I)	Who Ends Game	Number of Times Played (V, N, I)
A	P_V	P_N	W	Violator	(1,0,0)
B	$P_V + \beta$	$P_N - \gamma$	W	Neighbor	(1,1,0)
C	$P_V + \beta$	$P_N - \gamma - C_R$	$W - C_H$	Neighbor	(1,2,1)
D	$P_V - F$	$P_N - C_R$	$W - C_F$	Violator	(2,1,1)
E	$P_V + \beta - F$	$P_N - C_R$	$W - C_F$	Neighbor	(2,2,1)
F	$P_V + \beta$	$P_N - 2C_R$	$W - 2C_H$	Neighbor	(1,3,2)
G	$P_V - F$	$P_N - 2C_R$	$W - C_H - C_F$	Violator	(2,2,2)
H	$P_V + \beta - F$	$P_N - \gamma - 2C_R$	$W - C_H - C_F$	Neighbor	(2,3,2)
I	$P_V + \beta - F$	$P_N - \gamma - 2C_R$	$W - C_H - C_F$	Neighbor	(2,3,2)
J	$P_V - 2F$	$P_N - 2C_R$	$W - 2C_F$	Violator	(3,2,2)
K	$P_V + \beta$	$P_N - \gamma - 3C_R$	$W - 3C_H$	Neighbor	(1,4,3)
L	$P_V - F$	$P_N - 3C_R$	$W - 2C_H - C_F$	Violator	(2,3,3)
M	$P_V + \beta - 2F$	$P_N - \gamma - 2C_R$	$W - 2C_F$	Neighbor	(3,3,2)

Table 5.4. Payoffs Associated with Extended Game

As seen in Table 5.4, the inspector's decisions never end the game. Only the neighbor or the violator can choose to end the game by ceasing to reporting the violation or ceasing the violation, respectively. The violator will choose to stop violating whenever the fine associated with the violation is greater than the benefit that the violator receives from the violation. Otherwise, the violator will continue to violate. Notice that if the inspector fines the violator more than once, then the size of the fine increases linearly. Therefore, the relative size of β and the accumulated fine are important in determining the strategies of the violator.

A similar line of reasoning applies to the neighbor as well. The neighbor will continue to report the violation as long as the accumulated cost of reporting is less than the cost of the violation to the neighbor. The neighbor's cost of reporting also increases linearly with the number of times that the neighbor reports the violation. So the most important parameters for the neighbor are the cost of the violation, γ , and the accumulated cost of reporting. Again, in the neighbor is able to report online this may

reduce the cost of reporting by allowing complaints to be filed at any point in time. The neighbor has more opportunities to play in the long-time horizon game, therefore, her costs could accumulate more rapidly.

Although the inspector does not end the game, the inspector can influence which of these two players will choose to end the game. The inspector does this by choosing whether or not to inspect the violation and fine the violator. As long as the inspector refrains from inspecting, the neighbor's cost of reporting will be accumulating. As long as the inspector chooses to fine, then the violator's fine will be increasing. The inspector makes his choice depending on the relative costs of doing nothing and of fining, just as it was in the previous game. So the relative size of these two costs will determine the inspector's strategies in the game.

In fact, the structure of the long-time horizon game can be simplified into certain classes of equilibria. These classes and the associated payoffs are shown in Table 5.5. All the generic payoffs shown in Table 5.5 cover all of the possible payoff combinations that will happen in the long time horizon game. Basically, there are three types of situations that arise. First, the inspector and the neighbor can get involved in a situation where the neighbor keeps reporting the violation and the inspector does not inspect. This subgame ends either when the neighbor's cost of reporting has accumulated to the point that it is greater than the cost of the violation and the neighbor ends the game by ceasing to report the violation or when the inspector's cost of doing nothing increases relative to the cost of fining and the inspector chooses to fine.

CYCLE AND RESOLUTION	PLAYER	PAYOFFS
Class #1 (violate, report, do nothing) Neighbor ends game	Neighbor	$P_N - \gamma - \delta C_R$
	Inspector	$W - \theta C_H$
	Violator	$P_V + \beta$
Class #2 (violate, report, fine) Neighbor ends game	Neighbor	$P_N - \gamma - \delta C_R$
	Inspector	$W - \theta C_H - \sigma C_{IF}$
	Violator	$P_V + \beta - \sigma F$
Class #3 (violate, report, fine) Violator ends game	Neighbor	$P_N - \delta C_R$
	Inspector	$W - \theta C_H - \sigma C_{IF}$
	Violator	$P_V - \sigma F$
Where θ = number of times the inspector does nothing, σ = number of times the inspector fines the violator, and δ = number of times the neighbor reports the violation		

Table 5.5. Classification of Subgames in Long Time Horizon Game

At that point, the game jumps into another subgame that involves the inspector inspecting the violation and giving a fine but the violator continues to violate and the neighbor continues to report the violation. This subgame continues until either (a) the cost of the fine to the violator accumulates to the point that it exceeds the benefit of the violation and the violator ends the game, (b) the neighbor's cost of reporting accumulates to the point that it exceeds the cost of the violation, or (c) the inspector's cost of fining increases relative to the cost of doing nothing and the inspector chooses to stop fining the violator and returns the game to class #1, the first subgame discussed. Thus, the inspector's choice of whether or not to inspect determines which subgame we are in. If the inspector repeatedly chooses to do nothing, then the game continues a subgame where only the neighbor can end the game, not the violator.

In summary, the game with the long-time horizon reinforces the importance of the same relative costs as the previous games. For the inspector, the relative cost of doing nothing and fining are important. For the neighbor, the relative costs of reporting and of the violation are important. And for the violator, the relative size of the benefit of violating and the cost of the fine are important. This corroborates the implications of the previous games. In addition, the long-time horizon game shows that the costs to all three players accumulate with the number of times that they play in the game. As soon as one player's costs reach a critical threshold, become large relative to the other critical parameter, then that player will end the game. Because the inspector cannot end the game, the relative size of the accumulated costs determines whether or not the inspector will do nothing or inspect.

5.4 Discussion

As can be seen in the simple games illustrated above, one of the most important factors is the fine levied on the violator. Some jurisdictions increase fines for repeat offenders (Ellickson and Been, 2000), which will aid in stopping the illegal land use. Another aspect of the zoning game, is that some violators are developers that frequently face the Board of Zoning Appeals and Plan Commission. These developers may be concerned about their reputation inspectors and the local planning community (Ellickson and Been, 2000). Thus the type of violator, developer or homeowner, may be an important factor in the how quickly a violator complies with local zoning ordinances.

Another important factor is the cost of reporting for the neighbor. If the neighbor expects to have a hard time reaching inspectors and inducing an inspector to inspect the violation, we may expect that the violation will continue. In the repeated game, we

expect that a neighbor who has faced a high reporting cost because of a struggle may look the other way and not report if the inspector does nothing after the first report. On the other hand, we expect that neighbors who are well connected with local government will report often, because of the low cost and high probability of response from the inspector.

An extension of these simple games is the possibility of legal action through the court system, which takes the game and costs to another level. The violator and the city or the neighbor must accept large legal fees in order to go to court, as discussed in Chapter 2. Therefore, many of these disagreements remain outside the court system and only cease when the neighbor stops violating or the landowner stops reporting similar to our games. I expect that the previous simple games represent a great number of local land use enforcement cases throughout the country.

Our study investigates a common problem in zoning arena, as well as other types of local enforcement, how do you effectively enforce a rule when official inspectors have limited resources and are unable to canvas an entire jurisdiction? As discussed earlier, violations can be difficult to spot from afar and certain types of violations may only be visible during a short period of time. Therefore, like many police measures, zoning relies on citizen complaints to be enforced. One impetus for zoning within a community is to reduce nuisance violations, which impose costs on neighbors and the community. The neighbor games allow us to better understand the impact of zoning on the ground, as the institution is only as good as its enforcement. The games indicate that neighbor reporting is an important element in local land use enforcement, and neighbors can be effective monitors, if supported by fines and fairly responsive inspectors.

Neighbors also need to be aware of the zoning ordinances and zones that surround them to be effective monitors. Recently many communities have created electronic copies of zoning ordinances that are available online. We anticipate that access to ordinances through the convenience of the internet may increase the numbers of citizen reports. Furthermore, some communities have created parcel level zoning maps that are available online. These maps enable neighbors to determine whether a possible violation is actually an allowable use. Thus, we may see some changes in the number of reports and accuracy of citizen reports with the increased access to zoning ordinance information.

Overall this study indicates that citizen monitoring of zoning laws may be increased or decreased through the reduction of reporting costs. Thus, online GIS maps enable citizens to easily determine if a neighbor is violating the zoning ordinance will significantly decrease reporting costs for the neighbor. If a community only has phone numbers listed, I do not expect this to be any more effective than communities without online information. As demonstrated in the games, making online GIS technology accessible does not guarantee an increase in compliance if inspection depends on multiple citizen complaints, creating a free-rider problem in neighborhoods. Thus online GIS use by communities may improve compliance through the zoning game, but adoption is only one part of game.

Online information can be costly for communities to create and maintain. Furthermore, many communities rely on outside consultants to maintain GIS data, which may create information and contracting problems. Communities may find that they technically do not “own” the GIS information, so cannot allow citizens to access the

information. Some communities may be uncomfortable with releasing parcel level data, even though this information is public. There is also the classic problem of the digital divide in that citizen must have online access and some fairly sophisticated computer skills to navigate the internet and access information about their neighbors. Thus, we may find that online GIS parcel maps reinforce the divide in enforcement with wealthier, higher computer skilled neighborhoods receiving even more zoning code enforcement resources.

Another policy change that could improve compliance in some communities would be incremental increases in zoning fines enable communities to reduce the game cycling with repeat offenders by decreasing the relative benefit of violating. Future extensions of these games will examine the informal negotiations that frequently take place between neighbors regarding land use. Nesbit and I investigated the formal reporting route with our general games, but this is not the only means for neighborly resolution. Another extension of the game will evaluate the importance of reputation in long term interactions between inspectors and violators who are developers. The current simple games improve our understanding of the relationship between important variables in citizen monitoring of zoning ordinances. These games indicate that citizen monitoring may be viable in many communities where reporting neighbors expect that investigation and fines will occur with reports. It is important for policymakers to understand these games when creating laws will be monitored and enforced that rely on citizen complaints.

As has been demonstrated in the previous chapters, zoning is complicated and can be ineffective across some measures of land use conversion and fragmentation.

Reporting and enforcement can be costly and ineffective at reducing violations, which is causing many communities to evaluate alternative to zoning.

Chapter 6: Alternatives to Zoning: Means to Cooperative Management

By Abigail M. York

Zoning may protect some types of land cover or direct economic development within a county, but it is difficult to protect specific natural resources or community “treasures,” with zoning. Zoning works primarily by taking away rights to specific uses not through the promotion of particular types of uses and land management. Throughout the country a desire to manage land collaboratively for economic development, ecosystem management, and forest conservation has emerged. In this chapter, I explore the legal mechanisms that are available for collaborative management of forestland.

One of the major threats to the ecosystems of the Midwest is loss of habitat and how remaining forests are managed. As discussed in chapter 3, most counties in Indiana are experiencing forest loss, while some counties have experienced moderate forest regrowth. Collaborative approaches to forest protection and management could be used to protect large areas of forest on private land. Collaborative management of forest is an extremely difficult process, especially if cooperators are only bound through education and social norms. Landowners who voluntarily seek to create long-term collaborative management arrangements need formal institutions to guide the process, especially when property changes owners. In this study, I consider institutions that can be used to achieve landowners’ goals for land-use regulation and management.

My research is partially motivated by a group of Indiana landowners and conservationists who desire to collaboratively manage forestland. This group contacted the Indiana Department of Natural Resources to request state aid and guidance in the creation of what in effect would be a privately held “public” forest. This unconventional

request is echoed throughout the country by communities that wish to preserve natural resources and community characteristics through collaborative management . These landowners wanted to do more than preserve land as a state park or working state forest. They wanted to maintain private ownership, but keep this land forested in perpetuity. A group of Indiana landowners recently approached the Indiana Department of Natural Resources with a request for assistance in the creation of a “virtual state forest (Fisher, 2004).” What is a virtual state forest that landowners hope to create? Dr. Fisher, the State Forester of Indiana in 2004, indicated that the landowners were unsure about their goals for collaboration, but did have a broad goal of forest conservation.

If this Indiana community hopes to collaboratively manage their forest resources, they must establish institutions to guide their behavior. Communities frequently have limited resources to guide these collaborative efforts. This study provides some guidance and insight with an institutional analysis of the strengths and weaknesses of several legal mechanisms available for collaborative management. This review of legal mechanisms explores their breadth and places each mechanism on a spectrum of public- and private-ness of enactment and enforcement. I evaluate the potential use of existing government programs, as well as some private mechanisms, that could aid landowners’ attempts to collaboratively manage lands and protect natural resources. The challenge is the lack of tools designed specifically to encourage cooperation. Similarly, A number of existing government and private tools could be used to collaboratively manage forestland, although many of these tools have not previously been used in this context.

The demand for alternatives to zoning stems from some of the weaknesses of zoning, such as the large-scale jurisdictions and inability of planners to address citizen

concerns. Zoning, as currently implemented, is routinely criticized for its inability to protect natural resources and limit urban sprawl because government officials too readily grant variances and rezoning requests (Diamond and Noonan 1996). The issue of flexibility is not limited to zoning. Some tools that I discuss in this study may also be criticized for their malleability. The planning community is challenged to balance malleability, which may encourage development, and inflexibility, which may protect natural or cultural treasures.

This challenge has been identified and explored in Jane Jacob's classic book, *The Death and Life of the Great American Cities* (Jacobs 2002). Her criticism centered on planners' inability to mimic organic processes of city evolution. She was especially concerned about the segregation of uses that often resulted in less vibrant cities. Her critique led many planners to adopt more realistic short-term plans, but there is still an inherent conflict between the organic nature of city growth and planners' attempts to "plan" for the future city (Ellickson and Been 2000). Jacobs' argues that in many instances, the urban citizenry is best served when planning does not take the forefront, but rather supports small, local initiatives. Some of her criticism could also be useful in urbanizing landscapes.

In urbanizing environments with rapidly changing citizen demands and concerns over loss of rural amenities, the ability of zoning tools to create a vibrant peri-urban community is also limited. Furthermore, the ability of zoning to promote cooperative land management is also limited, as zoning functions primarily by taking away property rights on individual parcels. In terms of forestland preservation, zoning by itself may be unable to support localized demands for increased regulation and restriction of uses, but

local efforts to preserve forest should not completely reject zoning and planning. Zoning and planning could create a jurisdiction wide commitment to preservation, mixed-use development, and coordinating development with existing infrastructure that will enhance other efforts to preserve forests. This type of overlapping system of government, a polycentric system, provides opportunities for self-governing citizens to provide themselves public goods (Oakerson 1999). This may be necessary for areas with environmentalists that desire more stringent land use policy. This type of self-governing private land use policy is not limited to forestry or environmental concerns. A group of historic preservationists focused on maintenance of historic buildings and districts could use also use some of these private institutions. Elected officials and bureaucrats may find it difficult to serve these different interests, particularly competing interests in the local political economy, especially when these groups desire an increase in government regulation. Special use districts and governing structures with overlapping jurisdictions may better provide for a heterogeneous population (McGinnis 1999). Landowners seeking to cooperatively manage their land need to evaluate the land use regulations that already impact their property and assess how best to achieve their goals. In most locales, land is already under a polycentric system with many different governments and private servitudes governing usage rights on the same piece of land, for example the rights to build, conduct business, or house livestock. Within this study I explore public and private mechanisms that might be used in innovative ways for land use management, especially cooperative management.

I begin by describing the types of goals associated with collaborative management on private lands. I explore the strengths and weaknesses of contracting, property owners'

associations, conservation easements conservancy districts, and zoning. Specifically I evaluate the longevity, flexibility, transaction costs, and private and public benefits within a spectrum of public and private control over creation, alteration, monitoring, and enforcement. These tools represent a range of public and private options that landowners may utilize, but none were created expressly to collaboratively manage private land. I also evaluate the compatibility of each tool with the goal of coordinated land-use management on private property. This will enable landowners and policymakers to determine which tools best meet their needs.

Different actors are involved with each of the different type of land use control mechanisms, specifically in the creation and passage of operating rules, as well as enforcement. In zoning legislation, the landowner may be impacted by the ordinance, but the average landowner will not be involved in its development. In comparison to servitudes, the landowners can be creators of the servitudes, as well as the monitors. In the next section, I explore the goal of collaborative forest management in order to provide the context for the evaluations of the land-use controls.

6.1 Goals of Collaborative Management

In order to provide some legal mechanisms to protect forest, I must understand the attributes to be protected. Private landowners seeking to conserve forestland need to make several choices including: accessibility to the property by the landowners and other people, land-use management such as timber harvesting, and limits on development. Some legal mechanisms may be better suited for timber harvesting or limiting development than other mechanisms. The forestland attributes that the landowners seek to protect may be best achieved through several different mechanisms employed together.

The broader community may support the landowners' initiative by providing consistent planning and zoning that focuses development away from the targeted forestland, while a private government, such as a property owners' association, may provide more restrictive regulations for the landowners that voluntarily hope to create a virtual "state forest."

The challenges facing these Indiana landowners are similar for all those interested in collaborative management. With each particular decision regarding accessibility and allowable management practices, one type of legal mechanism may be more or less appropriate. In the following section I illustrate the spectrum of legal mechanisms available.

6.2 Spectrum of Legal Mechanisms

There are many mechanisms available to private landowners and communities that wish to restrict or promote certain uses on private property. These mechanisms include contracts, conservation easements, property owners' associations (POA), and zoning ordinances. Contracts are created between private parties and are the simplest mechanism included in this analysis. Property owners' associations are private governance organizations and include homeowner and condominium owner associations. Conservancy districts in Indiana primarily focus on water resources, although the enabling statute is quite broad (Indiana Conservancy District Act 1957). In this section, I discuss in detail the differences among legal mechanisms that could be used to protect private forests. There is a wide range of public- and private-ness associated with these legal mechanisms. I have split the legal mechanism into two major types of actions, creation and enforcement. The first is the decision to put one's land under an easement

or for a county council to enable zoning, as well as the landowners' ability to alter the institution after implementation. The second is the continued enforcement of the rules.

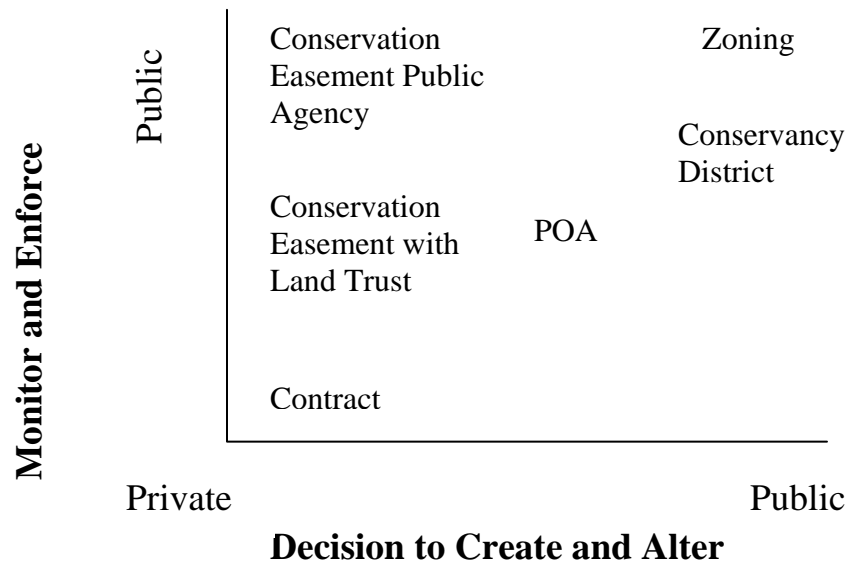


Figure 6.1. Legal Mechanism Spectrum-Publicness in Creation and Enforcement

As seen in Figure 6.1, there is a range of institutions that could be used to collaboratively manage land. One noticeably absent type of institutions is a mechanism that is public in creation, but private in monitoring and enforcement. It seems unlikely, although not impossible, that government entities would impose rules upon landowners and then leave monitoring and enforcement to private sector. As discussed in Chapter 5, monitoring of zoning is often lead by citizens, but enforcement is usually done by zoning inspectors and other government officials. One could imagine situations where creation of public regulations regarding land use leads to *de facto* private enforcement. As

demonstrated in Figure 6.1, besides the absent public creation and private enforcement institution, there is a wide range of institutions for communities to choose from.

6.2.1 Contracts

Some might argue that the private market should be able to develop a solution for the creation of cooperative forestland management units that are mutually beneficial to all parties involved. In the case of land-use disputes, private contracts or agreements do occur, especially in rural areas where the involved parties are acquainted. A farmer-developer may approach individuals within a community and try to establish an agreement without outside litigation or legislation (Rudel 1989).

Contracts are the most private with individual landowners making the decision to initiate the agreement, as well as the monitoring, enforcement, and altering, Figure 6.1. Landowners could negotiate the terms impacting each others' parcels. In comparison to the other legal mechanisms, a contract is usually relatively short term. This type of institution may be useful for proactive management, but of limited usefulness to long-term protection of openspace. The costs to negotiate mutually beneficial market solutions are prohibitive. If agreements are not attained or maintained the parties may resort to litigation. It may be difficult for a third party to monitor and enforce private contracts. A contracting scheme could be a short-term type of easement, as the landowner would agree to particular services for the organization such as timber harvesting or preservation. On the other hand, there would be transaction costs associated with each negotiation that may be prohibitive. Furthermore, some landowners may be reluctant to enter the agreement because of an inability to enforce the contract if the property is sold to another party.

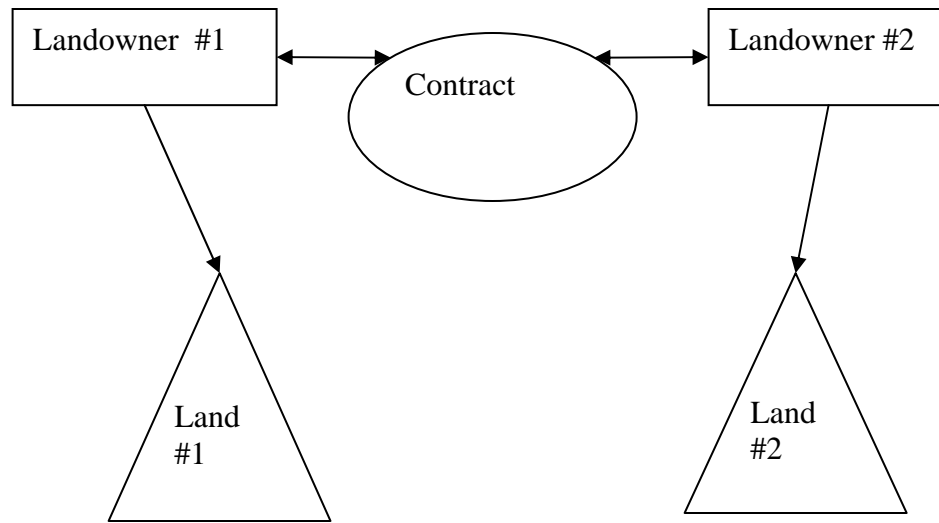


Figure 6.2. Contracts

One can imagine that this type of solution may be optimal for small groups of landowners who have strong relationships with one another. The landowners may need to continually change the contracts if land is bought and sold. Incoming landowners may be unwilling to restrict their land use to cooperate with the long-time residents. The other landowners would be unable to compel a new landowner to comply with the contract from the previous owner. Landowners could use contracts for coordinated timber harvests, working on watershed management, or planting species in specific locations. In summary, contracts may be effective, and the best possible legal arrangement, for precise, short-term projects.

6.2.2 Conservation Easements

Private servitudes, such as conservation easements, allow individual citizens acting through charitable organizations to increase the restrictions on nearby land in order

to promote a local public good, such as conservation of openspace (Ellickson and Been 2000). The servitude creators are able to design the restrictions on the property and register it with the deed, but future owners are limited in their ability to change the conservation easement. This rigidity has many benefits for neighboring property owners because it reduces the uncertainty associated with property use change, as well as to the larger community in conservation.

These easements often reduce the value of the property significantly, so landowners' may demand a substantial sum to sell the rights. Land under a conservation easement may incur a property tax reduction because the easement restricts use. The magnitude of this tax benefit varies from state to state depending on the tax laws. If a state has an ad valorem tax, a tax based on the highest and best use, the reduction most likely is greater than states with a flat forestry or agriculture current use tax system. Landowners who donate an easement will also receive a federal income tax benefit, as it is considered a charitable donation (York, Janssen, and Ostrom, forthcoming).

Once created easements are fairly inflexible, as the easement is for perpetuity. On the other hand, the easement is privately negotiated by the landowner and the nonprofit, so at the least the initial landowner should be satisfied with the institution. Land trusts and government entities are the primary holders of conservation easements.

As can be seen in Figure 6.1, conservation easements with land trusts are a legal mechanism that is private in creation, but more public in monitoring and enforcement. In the initiation, the landowner will work with the land trust's officials to determine the easement restrictions. Afterwards, land trusts often rely on volunteers to monitor the easement and activity on the property. If the land trusts fails in it's obligation to monitor

the easement government officials may step in. It can be extremely difficult for the landowner to alter the easement after initiation, a strong point for landowners interested in preservation. However, courts have forced modifications based on changes in circumstances and the resulting public benefits.

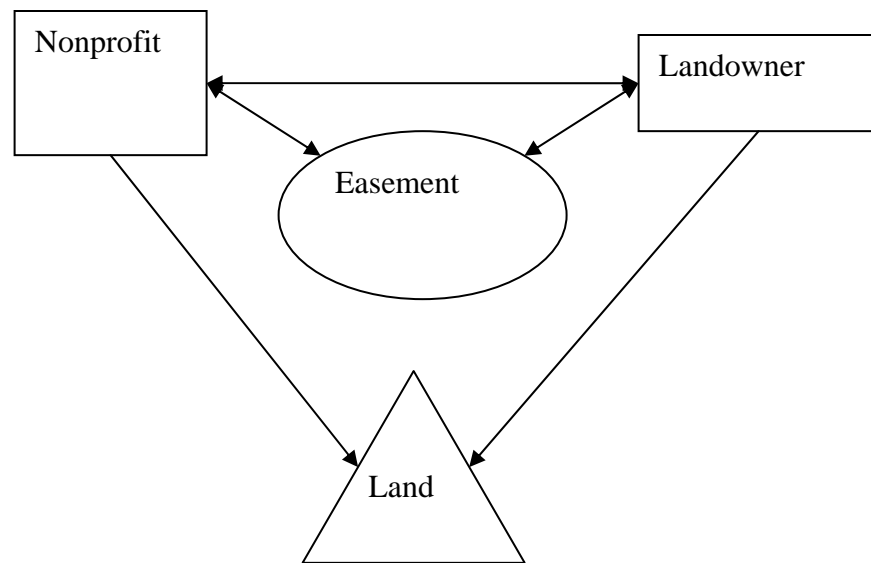


Figure 6.3. Conservation Easements

As can be seen in Figure 6.3, the structure of conservation easements is different than POAs or Conservancy Districts. With a conservation easement, a landowner negotiates with a nonprofit entity, such as a land trust or government entity, to restrict development on a property. Then the nonprofit monitors the property after the agreement. Money may exchange hands or the easement may be a result of a donation by a concerned landowner. Easements are fairly inflexible, as the easement is for perpetuity. On the other hand, the easement is negotiated by the landowner, so at the least the initial

landowner should be satisfied with the institution. Land trusts and government entities are the primary holders of conservation easements.

Conservation easements with governments may be fairly private in initiation, although monitoring is public (Figure 6.1). The landowner works with government agents, such as the Department of Natural Resources, to determine the terms of the easement contract, although sometimes the public or various commissions may be involved in the choice of properties. The Indiana Forest Legacy Program uses an advisory panel for input to help determine which properties should be targeted and their ranking for federal funds to purchase easements. After initiation, the monitoring process is public, with various groups conveying information to the government about activity on the property.

In order for a land trust or government to aid in collaborative land management, the nonprofit entity would need to coordinate with each individual landowner, which is extremely difficult, especially if all the landowners are seeking compensation for the loss of development potential. In Indiana, The Nature Conservancy, The Forest Legacy Program, and The Sycamore Land Trust have worked to enroll contiguous parcels, but it is an extremely difficult process.

As the needs of future landowners and the communities change, these servitudes possibly could have a negative impact on the community, although the conservation of openspace is relatively assured with the easement. Servitudes via land trusts can be an effective tool within a relatively small area, or for protection of specific types of properties. The conservation easements also can be shaped to the property owner's

needs, so there is some flexibility in the contract creation, but the agreements may not serve for the future population.

6.2.3 Property Owner Associations

Property owner associations take many forms, such as condominium associations and common interest developments. Such developments are the fastest growing in the country and make up almost all residential growth in California, Florida, New York, and Texas (Pena 2002). The governance of these associations can be extremely controversial. Resident board members are given extensive power over neighbors that can lead to conflict and abuse of power. There are a number of commentators who suggest changes to improve the governance of property owners associations, such as court recognition of the fiduciary duty of board members (Grassmick; Pena 2002).

POAs often have commonly held land such as pools, openspace, or recreational facilities. Landowners' behavior with regard to their privately held land and the commonly held land is restricted by property association rules. As pseudo-government organizations, landowners are also required to pay fees levied by the board of directors. The private government structure allows POA members to restrict use, possibly for openspace management.

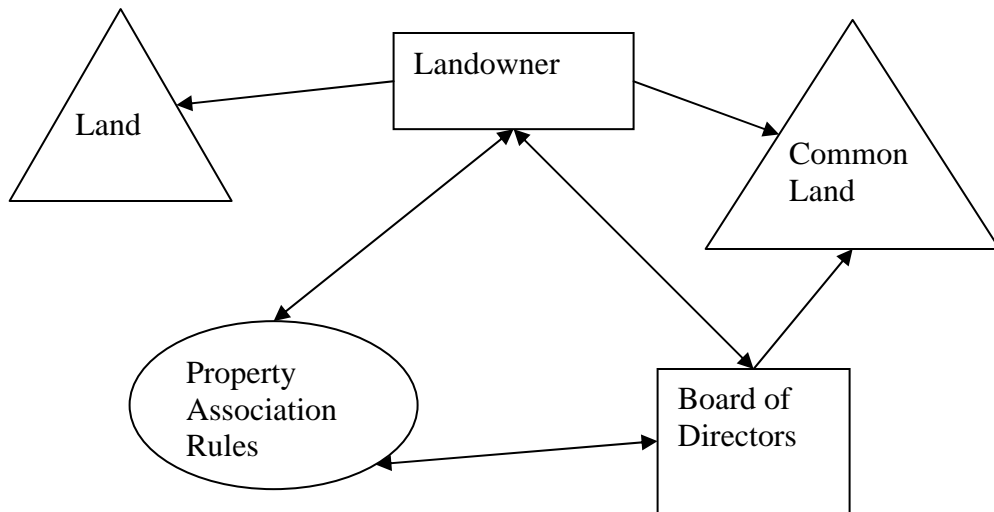


Figure 6.4. Property Owner Associations

There has been a cry of outrage regarding the growth of gated communities throughout the United States (Babcock and Siemon 1985). In these communities, property owners may gain some benefit from common park areas, as well as gain security from a gate with a password, or actual security personnel limiting access. Private planning through property owners' associations can be problematic, most notably in terms of the inflexibility of the regulations. The community may need to continually reference the original community plan in dispute resolution (Ellickson and Been 2000). POA boards may be unwilling to stray far from the original master plan for the community.

The strength of the private governments is that they can provide land use control measures for small neighborhoods that are not feasible within the larger community. Some associations create rules regarding appearance and maintenance of facilities,

whereas other associations create restrictions for environmental protection. These self-governing organizations allow citizens to plan and influence their community through more direct means than is possible through public planning. POAs may work well at providing various aesthetic controls and provision of community greenspace without additional restrictions via public zoning, but these private governments do not work with the outside neighbors to the community. “Public” areas within the community typically are restricted to use only by the housing association, so neighboring community members are unable to use public areas. Neighboring community members will receive some benefits from POA openspace protection in the form of habitat protection and preservation of the scenery.

Property owners’ associations represent a middle ground in creation, as well as monitoring and enforcement (Figure 6.1). Frequently, property owners’ associations are created by a developer, which could be considered a private action, as the developer holds property within the association. Sometimes, landowners come together after a development is established to create an association to deal with concerns such as road maintenance or security. Property owners’ associations have been used to manage parks and recreational areas, but could be used to collaboratively manage openspace. Property owners’ associations elect boards to deal with issues concerning the management of property. Thus, this may be one of the easiest mechanisms to adapt to land-use regulation for collaborative management.

6.2.4 Conservancy Districts

Conservancy districts are special purpose units of government that manage water resources, typically either watershed quality or maintenance of utility infrastructure. The

utility districts provide services such as sewage treatment and water supply. The watershed districts typically maintain lakes, including dams and the pumps that service the lake. Either type of district may collect user fees, taxes, or both. Districts are frequently divided into areas, which represent different interests or portions of a watershed. The areas have representatives on the board. Voters for the conservancy district are property owners, called freeholders, within the district. Freeholders may be individuals that hold life tenancy or fee simple estates.

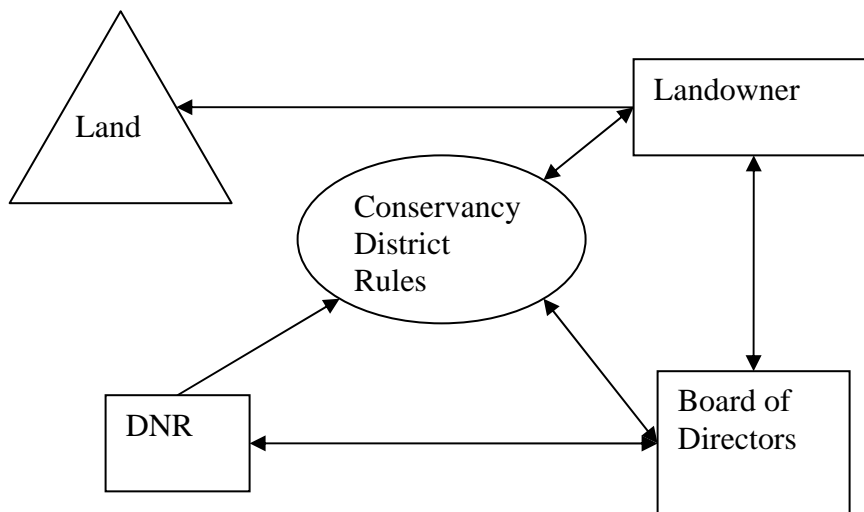


Figure 6.5. Conservancy District

As can be seen in Figure 6.5, the Indiana Department of Natural Resources is involved in the creation of the Conservancy District, as well as some general oversight. The Division of Water monitors the conservancy districts and focuses primarily on water quality in the districts with lakes and dams. The conservancy district is governed by a

board of directors who have authority to restrict use within the district and also to collect fees to maintain the watershed.

Landowners seeking to create a district must collect signatures from 5 to 30% of the freeholders (landowners) within the proposed district boundaries and petition the court for recognition (Indiana Conservancy District Act 1957). Individuals who wish to petition against the establishment need to obtain 51% of freeholders or freeholders who own 667% of the property value in the proposed district in order to prevent creation. In Indiana, many of the conservancy districts were created in conjunction with a POA. At the beginning of the development, prior to any other freeholders buying land within the district, the developer is the only freeholder, so there is no difficulty in obtaining the required freeholder support for creation. The Indiana Department of Natural Resources is involved in the creation of the Conservancy District, as well as providing general oversight of their operation. The Division of Water monitors the conservancy districts and focuses primarily on water quality in the districts with lakes and dams. The conservancy district is governed by a board of directors who have authority to restrict use within the district and also to collect fees to maintain the watershed.

Since conservancy districts are government entities with the ability to restrict land use within the district and have the ability to collect user fees and taxes, the district may be a good option for openspace management with a watershed management focus. Once a property is included in a conservancy district, future owners cannot remove the property from the district, which is both a strength and weakness. This restriction increases the long-term nature of the commitment, but also may limit the property's value.

On the other hand, conservancy districts can be seen as fairly flexible because the governing board of directors may change a district's policy at anytime. Conservancy districts require a time investment by landowners to vote in the elections and hold office, which has been a problem for some districts in Indiana. Thus, some conservancy districts are defunct, although still technically government entities. Property owners can vote to remove the district, although this is rare in Indiana¹.

Conservancy districts have used district monies to hire engineers to handle problems with dams, drainage, and lakes. One could imagine that a modified district would be able to use monies to hire foresters and wildlife scientists to manage land. In summary, the conservancy district represents an interesting government option for collaborative management, as the jurisdiction boundaries can be determined by the needs of the community and natural features, rather than existing political boundaries.

6.2.5 Zoning

The practice of planning and zoning was begun to deal with problems stemming from conflicting land uses that previously were dealt with through nuisance litigation. Zoning has evolved to include promotion of the public interest, such as community aesthetics. Zoning is an effective means to reduce nuisances such as restricting the ability of residents to raise livestock in urban areas, thus preventing unwelcome noise and smells. Zoning is also seen as a fairly effective means to stabilize property values within a residential area (Fischel 1985).

Zoning can be detrimental to other community goals. Carruthers has argued that zoning, as currently implemented, can be detrimental to the preservation of openspace, as it encourages the leapfrog phenomenon, i.e. pushes development into rural areas less

¹ Information Obtained from the Indiana Association of Conservancy Districts

restricted by zoning (Carruthers 2003). Similarly, Diamond and Noonan (1996) and Dowall (1988) see local level zoning as out of touch with modern goals, such as prevention of sprawl. As described in Chapter 3, zoning does not protect agricultural or forestland. In Chapter 4, we found that zoning as currently implemented can lead to forest fragmentation

The problem with zoning as currently implemented in Indiana for collaborative management of openspace stems not from its localized nature, but rather that zoning jurisdictions typically are too large. Zoning may prohibit particular uses, but affirmative requirements, such as requiring landowners to undertake management activities required for critical habitat types can be more difficult to achieve especially without a link to public safety.

Historic preservation zones have been used to maintain historically important areas. Historic preservation districts have been used as a means to impose affirmative requirements on landowners like maintenance of historic properties. Historic preservation legislation could be adapted for openspace preservation, although it may be difficult within a large jurisdiction. Furthermore, since only a limited number of landowners seek to manage and conserve not just preserve their land, the historic preservation similarity may be limited. If zoning was implemented to preserve openspace more forcibly, restrictions could be imposed on landowners rather than relying solely on voluntary programs. There would surely be legal challenges to these types of laws because communities are often unwilling to enforce unpopular zoning rules. It seems unlikely that communities would be willing to pass or fight for these types of

restrictive laws on openspace. Collaborative management assumes a desire to actively manage their land, which many citizens are unwilling or unable to accomplish.

Zoning, either local or county, represents public initiation and monitoring, enforcement, and altering. One could imagine that special zones could be created, similar to those for agricultural preservation that attempt to promote collaborative management. Within Monroe County, Indiana, forest preserve zones are already in place, although the rules within these zones do not regulate forest management activity. The difficulty of using zoning for collaborative management rests in the relatively large size of the jurisdiction and in the public process, which may make it difficult for individuals seeking fairly restrictive preservation-oriented rules.

6.3 Conclusion

Depending on the needs of the community, all of these legal mechanisms could be used to promote various aspects of collaborative management. Zoning could be used to help direct development away from the collaboratively managed land. A conservancy district would enable more active management activities through a special use district, although the public hearings may make restrictive policies difficult. More restrictive or active management goals could be pursued through property owners' associations, conservation easements, and contracts.

Collaborative management is an emerging objective throughout the United States, especially with respect to preserving large areas of forestland. As can be seen, zoning can be used to promote this goal, but it may difficult to achieve preservation or active management solely with zoning or government mechanisms. Sometimes citizens with minority policy preferences may opt for private provision or regulation (Janssen and

York 2004). Thus, private or pseudo-government options may be the means to achieve land-use regulation.

Collaborative forest management is not the only type of management that could use the mechanisms described previously. Watershed management goals are already achieved through combinations of tools, especially property owners' associations and conservancy districts. Economic development and historic preservation could also be achieved by using some of the previous tools. Historic preservation districts often are a part of comprehensive plans, although more active management and increased restrictions could be achieved through use of contracts and property owners' associations. Economic development could be promoted through an economic type of conservancy district.

Zoning can be a useful tool for land use management, but other private and semi-private tools are often overlooked. Public planning should not be the only option, similarly neither should private. Rather a diversity of legal mechanisms can best serve the types of goods that are demanded by the population. The diversity of mechanisms employed may also be related to the mobility of the population, government insensitivity to citizen demands, and minority preferences.

Chapter 7: Growth of Private Governance in the Land Use Arena

By Abigail M. York¹

Introduction

As discussed in Chapter 6, citizens are seeking alternatives to zoning to protect natural resources and manage ecosystems. The demand for these alternatives may stem from a variety of sources such as the inflexibility of the zoning mechanism, which is designed to restrict allowable uses instead of promoting manage activities. On the other hand, dissatisfaction with local government land policy, specifically zoning, maybe due to the disjunction between citizens' preferences and local land use policy may be due to official or bureaucratic insensitivity.

The preference distribution of the population may create a pocket of people desiring more restrictive zoning regulations, but are an underserved minority. Janssen and I designed the following computer experiments to investigate the growth of nongovernment organizations in local political economies. The experiments were not specifically designed for land use policy, although zoning represents one type of policy within a larger local political economy. Thus in this chapter, I will use land use policy to highlight the empirical relevance of the experiments that Janssen and I developed for a more general investigation of local political economy. In the discussion section, I will illuminate some of the shortcomings of the current experimental design, specifically its aspatial nature. These experiments illustrate important conditions that create demand for nongovernment regulation or service provision, such as changing citizen preferences.

¹ This chapter draws on work coauthored with Marco A. Janssen, "The niche of non-governmental organizations in a changing landscape of citizens' preferences," presented at the 2004 Annual Meeting of the American Political Science Association, September 2 - September 5, 2004. Marco Janssen was instrumental in the development of the computer model.

In southern Indiana, Carlson et. al (2002) found a large number of nongovernment environmental programs. These programs included certification, easement, and educational programs. Some were similar to those discussed in Chapter 6. In this chapter, I investigate the conditions under which we expect growth of nongovernment land use institutions. Janssen and I model a public service provision world where citizens are served within the public sector by government bureaucrats or privately through NGOs. We are interested in the growth of NGO service providers due to inadequacy of bureaucratic provision. We explore the conditions when citizen policy preference change leads to NGO sector growth. We are especially interested in how mismatch between elected officials' party platforms and citizens preferences can create a niche for NGO provision.

It is important to understand the creation of NGOs within local jurisdictions, as we have seen a rise in many types of NGOs, such as common interest developments (Fenster 1999; Helsley and Strange 2000) and land trusts (Press et al., 1996). Within the USA, environmental NGOs have been an integral part of the conservation and preservation movement providing a means for individuals to protect their land through conservation easements, technical assistance, and education (York et al., in press). Within the education system, private schools have long provided a private option when public schools were not available or inadequate. Common local government services, such as garbage collection and policing, are often supplemented by private providers within the community (Lyons and Lowery 1989). Recently federal initiatives, such as the Faith Based Initiative, have encouraged NGOs, specifically religious organizations, to provide

public goods. The Janssen and York model is generally applicable to many different local policy issues, but I focus on its application to land use policy in this chapter.

Within the land use policy arena, control over growth and aesthetics are typically contentious debates in almost every type of community, although as mentioned in Chapter 2, urbanizing environments are often subject to the most change in both land uses and citizen preferences, as exurbanites move into rural areas. Donovan and Neiman (1992) investigate how citizen mobilization leads to growth control policy adoption. Their analysis focuses mainly on the ability of citizens to influence adoption of growth controls in comprehensive plans and zoning ordinances. In our abstract model, one can think of government provision of growth controls and other land use restrictions, as well as provision of other types of land regulations and services.

In our model, citizens may use NGO institutions to replace or supplement government service provision of similar services and regulations. As I discussed in Chapters 2 and 6, zoning and private alternatives provide goods, such as preservation of historic buildings, management of forestland, and control over neighborhood aesthetics. Thus, a group of citizens demand zoning and private institutions to create or protect both public and private goods, such as aesthetics from countryside, as well as property values for individual landowner. The highly mobile nature of our society frequently means that within a jurisdiction the policy preferences of the citizenry shift fairly quickly overtime. One common example of this process is when peri-urban areas are populated with exurbanites causing a change in the community from “rural” preferences to a citizenry that demands the amenities of a suburb (Rudel, 1989). There are several examples of preference change processes including gentrification, movement of different ethnicities

and races, or movement of retirement communities into jurisdictions. This computer model focuses on increasing minority preference populations within a community creating a demand for NGO service provision.

Tiebout (1956) argued that citizens make their location decision based on the package of public and private services within the community. In the Janssen and York (2004) model, we assume that citizens are making their location decision because of goods external to the policy arena that we are modeling. We focus on the impact of citizens entering the jurisdiction on elections and public good provision within their chosen jurisdiction. I apply our results to the land use policy arena, to understand the conditions under which alternative institutions will be created.

We model interactions of citizens, elected officials, and bureaucrats as a principal-principal-agent problem. Within our model, citizens vote for officials whose party platform is closest to their policy preferences. After election officials balance desire for reelection with their party ideology in their policy adoption decisions. In between elections, officials are able to access polling results in order to update their platform. Bureaucrats implement the programs that are handed down from the elected officials, but they also slightly modify the programs to fit with the citizens' preferences. Bureaucrats balance between the citizens and elected officials' desires in order to maintain job security and limit complaints from citizens. The NGO in our model is created when there is a gap between public service provision and citizen desires.

Many researchers have explored the idea of "voting with your feet" (Lyons and Lowery, 1986; Ostrom et al., 1978; Ostrom et al., 1961; Schneider, 1989; Tiebout, 1956). Moving is one means for dissatisfied citizens to improve the mismatch in preferences

with public good provision, although several other means have also been explored in the exit, voice, and loyalty theory, including political protest and campaign contributions (Hirschman, 1978; Lyons and Lowery, 1986). Lyons and Lowery (1989) also discuss exit to alternative private service providers for specific public goods. In this paper we are focusing on this Lyons and Lowery type of exit to NGO provision, while allowing citizens to also exercise voice through voting and polling in between elections. The experiment application to land use policy in an urbanizing landscape is especially important because of the dynamic preferences changes, as exurbanites move into rural and peri-urban areas.

In our model, interactions between citizens, elected officials, and bureaucrats are a principal-principal-agent problem. Within our model, citizens vote for officials whose party platform is closest to their policy preferences. After election officials balance desire for reelection with their party ideology in their policy adoption decisions. In between elections, officials are able to access polling results in order to update their platform. Bureaucrats implement the programs that are handed down from the elected officials, but they also slightly modify the programs to fit with the citizens' preferences. Bureaucrats balance between the citizens and elected officials' desires in order to maintain job security and limit complaints from citizens. The NGO in our model is created when there is a gap between public service provision and citizen desires.

Many researchers have explored the idea of "voting with your feet" (Lyons and Lowery, 1986, E. Ostrom et al., 1978, V. Ostrom et al., 1999, Ostrom, Tiebout, and Warren, 1999, Schneider, 1989, Tiebout, 1956). Moving is one means for dissatisfied citizens to improve the mismatch in preferences with public good provision, although

several other means have also been explored in the exit, voice, and loyalty theory, including political protest and campaign contributions (Hirschman, 1978, Lyons and Lowery, 1986). Lyons and Lowery (1989) also discuss exit to alternative private service providers for specific public goods. In this paper we are focusing on this Lyons and Lowery type of exit to NGO provision, while allowing citizens to also exercise voice through voting and polling in between elections.

The ability of citizens to exit the political process or at least portions of the process, through private service providers has generated some concern. Specifically, Helsley and Stronage (2000) explore exit into exclusive common interest developments and private schools. They investigate the problem with the “cream” of the society lives in exclusive gated communities or the upper classes send their children to private schools. Many researchers have found that middle to upper class professionals were often instrumental in citizen mobility for growth control management (Babcock, 1966, Donovan and Neiman, 1992). In our model citizens opt for private institutions only after their dissatisfaction reaches a threshold. We model these individuals as exiters on particular issues, rather than exiting from the political process as whole. We believe that this better reflects the nature of growth control, as well as many local political economy policy decisions. Citizens typically pick and choose government and private options, rather than completely exiting the process as a whole. Even citizens in gated communities that provide additional police protection, aesthetic controls, road maintenance within the gates, and recreational services typically depend on local governments for additional services such as police protection, fire and rescue service, and park provision.

Overall our model brings together several streams of literature on NGO creation and citizens as consumers and entrepreneurs. We are not exploring citizens' ability to vote with their feet, but rather their ability to use NGO services in place of public services. The Janssen and York model (2004) extends the Kollman et al. (1997) model to include bureaucrats, as well as citizens and elected officials, as policy adoption and implementation frequently may differ. This model allows us to evaluate how evolving citizen preference distributions leads to NGO creation. In the following sections, I will explain the model components: the adaptive parties, entrepreneurial citizens, and bureaucrats. Then I discuss the results from the experiments, the general local political economy and the link to the land use policy arena. I conclude by describing future extensions of the model that will more accurately model the land use policy arena, as well as future directions for empirical research.

7.1 Model

In urbanizing environments, new residents often demand more stringent land use controls to protect their home values (Babcock and Siemon, 1985), while long term landowners using land for extractive uses may be less inclined to push for stricter land use controls. In Chapter 2, we explored how urbanization may cause a change in the demand for regulation. In the following experiment, we model how citizen mobility may change this demand. Specifically, we investigate how the rate of citizen preference change due to mobility, or due to other external factors such as for example the realization that a resource is at risk, influences the local political economy. The abstract

computer model relates to the empirical land use policy environment that I have described in the previous chapters.

In the Janssen and York model, there are elected officials who are within an adaptive party, bureaucrats, and citizens. The elected officials are primarily concerned with reelection and implementation of their platform. Citizens are able to vote, express their opinion through polling in between elections, and create alternative nongovernment institutions. Citizens also choose between nongovernment and government program options. Bureaucrats focus on balancing the competing demands of citizens and elected officials. In the following subsections, I describe the underlying formulas for each of the actors.

7.1.2 Adaptive Parties

Within our model, there are two parties competing for V votes in a n -dimensional issue space. The preferences of each voter are represented by a vector of n integers. The vector \mathbf{x} represents the ideal positions on each issue out of k possible positions. The platform of a party is defined as $y \in \{0, 1, \dots, k-1\}^n$. The expected utility to a voter from this platform is defined as the squared weighted difference between the ideal point and the platform, scaled to a range between 0 and 1, and as defined as

$$u_i(y) = \sum_{j=1}^n \frac{(k-1)^2 - (x_{ji} - y_j)^2}{(k-1)^2} \quad (7.1)$$

As noted in Krebs (1998) many local elections are now nonpartisan, although the local party organization is often courted by candidates and officeholders in order to receive

endorsements or campaign finance in nonpartisan elections. In our model, officials are officially or unofficially connected to a party with a party ideology and platform. In line with Kollman et al. (1992) the parties adjust their platforms to win elections. We assume that the parties have some ideologies \mathbf{X}^I and that they may adapt their program within a tolerable change T_{max} to maximize the probability to win the elections.

The parties adapt their platforms by estimating the share of the votes that they may receive, and update the program if it increases the expected share of votes. In an iterative way, the parties adapt their program. The estimation of the share of votes is derived by sampling the opinions of the voters. A random sample of voters is “polled” enabling party platform adjustment between elections. In the poll, the voters sampled, V_{sample} , are assumed to give an honest reply. These polls may be considered actual polls, or citizen responses that are gathered through other vehicles such as public hearings, public surveys, newspaper accounts, or interaction with elected officials. We explore different degrees of change among the preferences of citizens, as discussed in the experiment section below. Parties may adapt their ideology to reflect the changing citizens’ preferences. With a probability p_I the ideologies \mathbf{X} of a party on a particular issue are adjusted. We simply assume that \mathbf{X} changes linearly with changes in the average preferences among the citizens.

There is mixed evidence regarding the impact of public polling on official activity. Greenwald et al. (2003) argue that polling is most effective in determination of the agendas for legislatures, but not necessarily important in the determination of actual legislation. We allow the elected officials to alter their policies after polling, but these officials still consider their party ideology. In our experiment, we test how government

adaptation after polling impacts the citizen satisfaction and NGO creation. In our simulation we assume that each party can adapt 5 times their program, and every time they can tinker their program, they can try out 8 adaptations. This is in line with the adaptive party model of Kollman et al. (1992) and simulates a kind of local search routine in a political landscape.

The elected officials set priorities for policy implementation, which balance the probability of being reelected and the match of the implemented programs and their ideals. Thus the elected officials maximize

$$u_i(y^I) = P[electd]^{\gamma} \cdot \left(\frac{1}{n} \sum_{i=1}^n \frac{(k-1)^2 - (y_i^I - X_i^I)^2}{(k-1)^2} \right)^{1-\gamma} \quad (7.2)$$

The expected share in the next election is derived by sampling a share of the population on whether they will vote for the party with the program y^I . The second component varies between 0 (maximum mismatch), and 1 (perfect fit). The parameter γ reflect how much weight the elected officials put on getting reelected versus implementing the programs according to their ideology.

7.1.2 Entrepreneurial Citizens and Bureaucrats

After the elected officials determined their program, we allow preference change within the population of citizens. With a probability p_{influx} we update the preferences of a citizen across the seven issues. In all experiments we start with a population with preferences in the lower bound of possible positions, say 0 and 1, and these preferences are updated with higher values up to $k-1$. When p_{influx} is low, there will be an increasing

diversity of preferences over time (Figures 7.1 and 7.2). When p_{influx} is high there is a moving cohort of preferences (Figure 7.3).

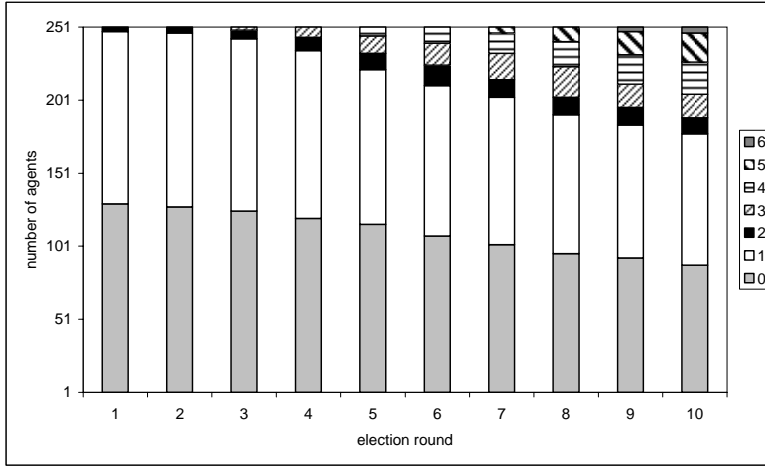


Figure 7.1. Example of distribution of opinions on an issue when p_{influx} is 5%.

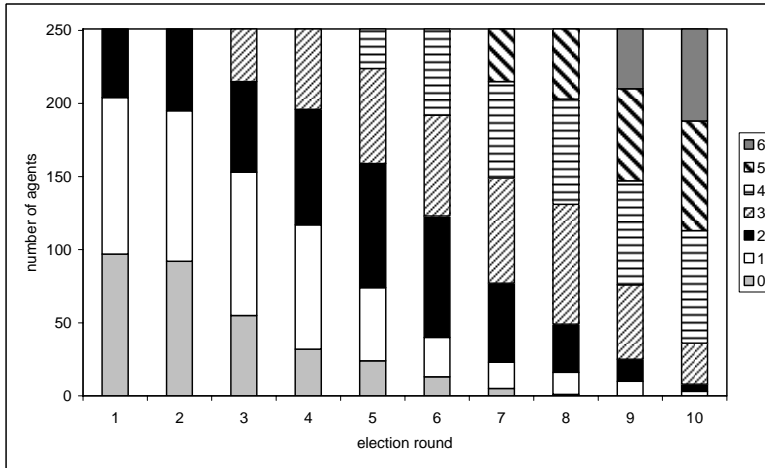


Figure 7.2. Example of distribution of opinions on an issue when p_{influx} is 40%.

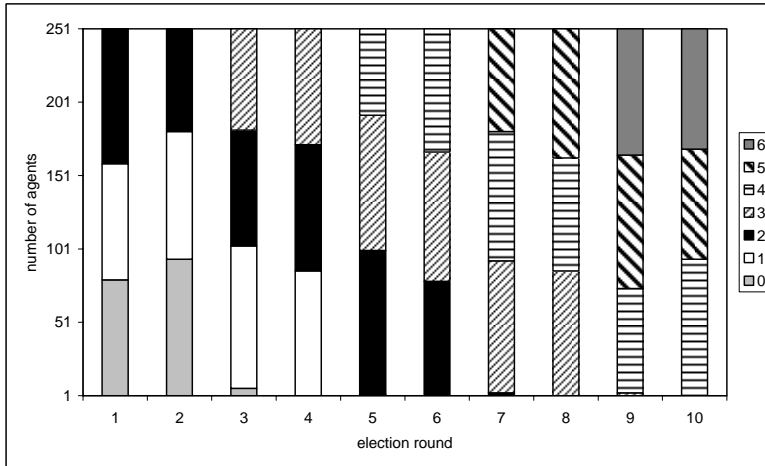


Figure 7.3. Example of distribution of opinions on an issue when p_{influx} is 95%.

Given the proposed program of the elected official, the bureaucrats implement the program. The bureaucrats are assumed to take into account the queries of both the citizens and the elected officials. If the citizens' preferences are not taken into account, they may start to complain to the elected officials about the provided services. As I discussed in Chapter 5, bureaucrats like the zoning inspector are often caught in the middle of citizen and elected official demands, especially when citizens like the violator and reporter are demanding completely opposite results.

The bureaucrats chose for every issue i the position j such that Ω_{ij} is maximized.

$$\Omega_{ij} = \left(\frac{(n-1)^2 - (y_i^I - j)^2}{(n-1)^2} \right)^{\gamma_b} \cdot \left(\frac{1}{V_{sample}} \sum_{l=1}^{V_{sample}} \left(\frac{(n-1)^2 - (x_{il} - j)^2}{(n-1)^2} \right) \right)^{1-\gamma_b} \quad (7.3)$$

Where γ_b express the weight of the bureaucrats on the satisfaction of the elected officials versus the citizens. Thus, we assume that bureaucrats are attempting to satisfy both elected officials and citizens in order to reduce conflict.

There are two prevailing theories regarding bureaucrats' activities. One of the theories argues that bureaucrats seek to influence policy outcomes by imposing their preferences. Another theory argues that bureaucrats seek to increase the budgets in order to reduce their workload and increase their prestige.

Wintrobe (1997) argues bureaucrats may seek to implement their preferred policies or maximize their budgets. The principal-agent problem with bureaucrats and politicians is partially solved by creating competition between agencies, so the

bureaucrats are more concerned about job security and seek to implement efficient programs that mirror politicians' preferences.

Torenvlied and Thomson (2003) use evidence from Dutch local authorities to argue that a multi-stage approach to implementation better predicts policy implementation than a political bargaining approach. Torenvlied and Thomson's research support the theory that agencies are not always able to affect the actual political decision, but rather are able to shape implementation.

One means for bureaucrats to control policy implementation is through information asymmetry and technical knowledge about an issue. Ringquist et al (2003) investigate the effects of salience and technical complexity on the elected officials' control of bureaucratic action. They argue that public salience of an issue will create incentives for legislators to watch bureaucratic activity, whereas complexity of an issue will reduce the ability of legislators to monitor. They find some evidence in the quantity of legislative activity for particular types of issues, high salience/high complexity, low salience/low complexity, high salience/low complexity, and low salience/high complexity, which support these conclusions. Thus, there is room, especially in low salience and high complexity, issues for bureaucratic influence.

In our model, as described earlier, the bureaucrats are seeking to balance political pressure from citizens and elected officials. They are possibly given some room for influence through vague policy directives from the elected officials or due to inability of elected officials to monitor. We are not modeling the budget-maximizing bureaucrat, but rather a conflict-minimizing bureaucrat in this model.

We can calculate the dissatisfaction of the citizens about the provided services by the bureaucrats. The dissatisfaction of a citizen j about a policy issue i is denoted as δ_{ij} and is defined as the squared difference between the opinion of the citizen and the provided service, times the strength of the issue for the citizen.

$$\delta_{ij} = (x_{ij} - y_i^I)^2 \quad (7.3)$$

As consumers, citizens chose between government or nongovernment services. Lowery (1998) argues that citizens are often ineffective in their evaluation of public services in a quasi-market environment. Lowery focuses on the quality of the services provided. We are not focusing on efficiency of the provision, but rather that the citizen views the NGO provider as more closely matching his/her preference.

When there are NGO's we can also calculate the dissatisfaction of a citizen for the NGO programs. In such a case the y_i^I is replaced with y_i^{NI} . In case a citizen is dissatisfied beyond a threshold δ_{\max} for all options, both governmental and non-governmental, the citizen will create a new program where the y_i^{NI} is equal to the preference of the motivated citizen x_i for that particular issue. We are building on Olson's idea regarding collection action that individual citizens will not produce a public good unless extremely motivated by their individual marginal costs and benefits (Olson, 1965).

Nowness and Neeley (1996) argue that political entrepreneurs are essential in the creation of interest groups and that individual support of these groups determines the longevity of the organization. In our model, a political entrepreneur is a citizen

motivated by his/her preference mismatch with the programs that are implemented. This citizen creates an NGO that then must be supported through participation by other citizens. We investigate how the transaction costs for NGO creation and participation change the political environment. Thus, we explore at what point a citizen is willing to invest resources into NGO creation and acknowledge Olson's (1965) collective action theory with its expectation of NGO activity limited by transaction costs and marginal, individual benefits.

We assume at $t=0$ that there are no NGOs. Through the experiment we investigate the creation of NGO programs. At each time point, given the current options of programs, the program of the elected government and the NGO programs, the citizen will select which program to join. For each program, the agent calculates the expected utility, taking into account the extra transaction costs for NGO programs,

$$P_{ij} = \frac{e^{\mu(u_{ij}-c_j)}}{\sum_{j=0}^{\#ngo} e^{\mu(u_{ij}-c_j)}} \quad (4)$$

Where $j=0$ is the governmental program, and $c_0=0$

In our model, NGOs represent an alternative to public service providers. In some policy arenas, such as land use policy, NGOs have been more responsive to citizen preferences (York et al., in press), while in other arenas, such as healthcare, Johnson and Bond (1982) found that NGOs may be unresponsive to consumer preferences, like a preference for abortion services. Within our model, in the ten abstract policy arenas the NGOs are

created and maintained when there is a significant population that is not served by the government service providers.

If an NGO program is not used, say less than n_{\min} users, than this program is taken out of the population of NGO programs. Thus we assume that a minimum amount of users is required to make a NGO program able to overcome the transaction costs. As Nowness and Neeley (1996) argue, there needs to be a group of individuals contributing to the maintenance of a NGO.

7.2 Experiments

In our basic experiments we assume we have 251 types of voters. These “voters” represent classes of citizen types. These voters are assumed to vote in every election, and provide honest responses when a random sample is polled between elections. We assume that these types represent classes of preferences of voters within our society.

Number of voter types (V)	251
Number of voter types polled in a sample (V_{sample})	51
Number of positions per issue (k)	7
Number of elections	10
Number of issues (n)	10
Steepness of effect utility differences on probability of participating program (μ)	20
Exponent utility function elected officials reelection versus probability of implementing own preferences (γ)	0.5
Exponent utility function bureaucrat weighting satisfying citizens versus elected officials (γ_b)	1
Maximum tolerable dissatisfaction (δ_{\max})	0.3
Transaction costs for NGO programs (c_j)	0.4
Rate of change of parties to adopt to changing preferences (η)	0
Rate of influx of citizens with new type of preferences (p_{influx})	0
Maximum tolerable adjustments of parties compared to their ideology (T_{\max})	0

Table 7.1. Parameter Values in the Default Case of the Simulations

Each condition below was simulated 100 times for 10 election rounds. The results show the average state of the system after the 10th election round. When we make statements of significant differences between different parameter settings, we have taken into

account the standard deviation of the results for the 100 simulated runs per parameter setting. Preferences of agents are updated between 2 election rounds. Each time the preferences are updated there is a probability p_u that the preferences of an agent are updated. If the preferences are updated, the new preferences are drawn from $\min(k-1, 0.5 \cdot r_e + u[0,2])$. As a result new preferences appear from 0 and 1 at the beginning of the simulated period to opinions 5 and 6 around the 10th election cycle (see Figures 7.1, 7.2, 7.3). Such a change of preferences could represent replacement of an older generation by a new one, or people from outside the region with different preferences moving into the region.

In the first set of experiments we vary the rate of preference change p_{influx} . We see that up to 25% influx per election lead to a sharp reduction in the participation in governmental programs (Figure 7.2).

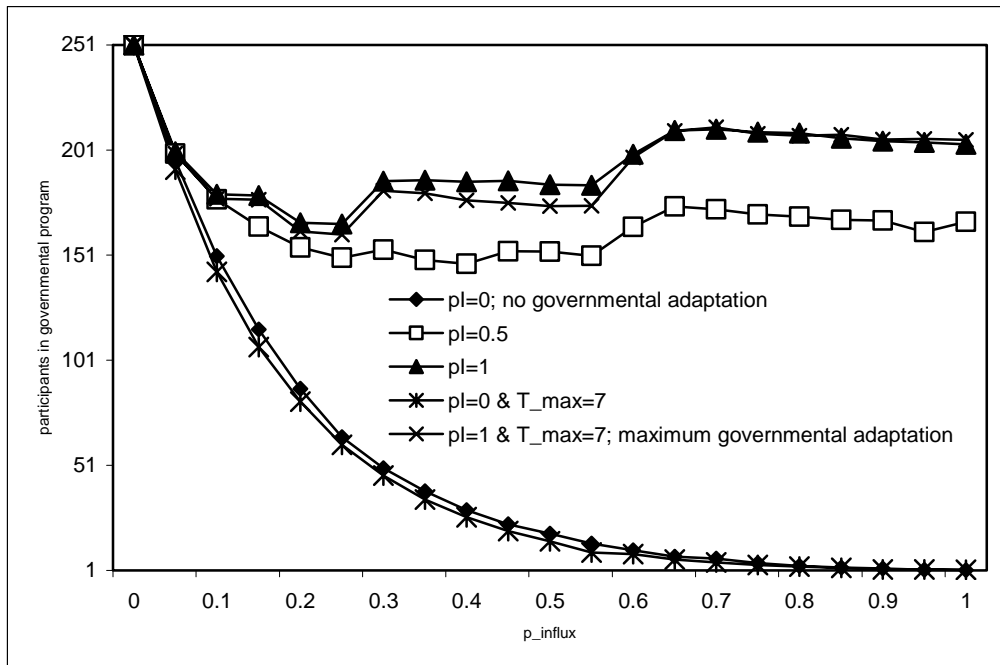


Figure 7.2. Number of Voters Using Government Programs

Note: This is after 10 election rounds for different levels of p_{influx} as an average of 100 runs, for different parameter values. p_l refers to the probability of parties to adjust their ideologies.

When p_I is equal to 0, and governmental parties do not change their ideologies, the participation in governmental programs declines, and there is a moderate number of successful NGOs who provide services (Figure 7.3).

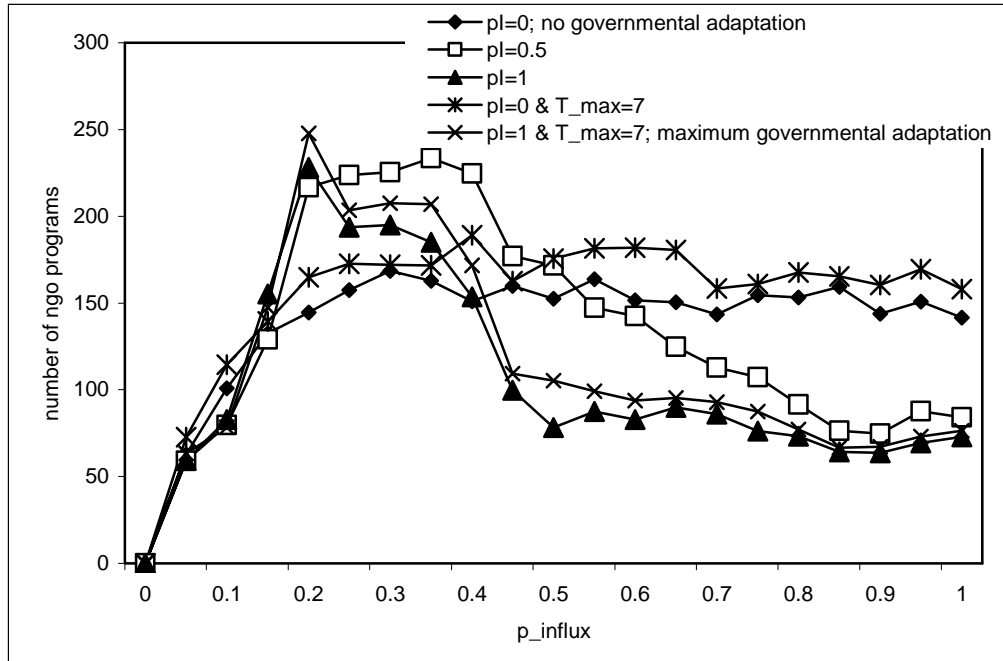


Figure 7.3. Number of NGOs

Note this is after 10 election rounds for different levels of p_{influx} as an average of 100 runs, for different parameter values. Note that p_I refers to the probability of parties to adjust their ideologies.

For p_I equal to 0.5 or 1, representing more adaptive parties' ideologies, interestingly there is a larger number of NGOs. Under this adaptive party condition NGOs are created that cater to agents that previously were served by the traditional party lines. But due to the adaptation of the government, the decline of participation in governmental programs does not continue to decline under moderate levels of preference change and actually increases under high probability levels of preference change (Figure 7.2). When p_{influx} is greater than 0.5, the rate of change becomes sufficiently large that the both the government and NGOs have trouble to keep up with the changing preferences (Figure 7.3). With a

moderately adaptive government, p_I is equal to 0.5, the number of NGOs declines almost to the level of a totally adaptive government when p_{influx} approaches 1. As expected under static government ideology, NGO program numbers are highest with probability of preference change. The greatest number of NGO programs is found under unadaptive or moderately adaptive party ideologies with p_{influx} between 0.2 and 0.4.

We also analyzed the impact of flexibility to ideology. Obviously, if governmental parties are adapting, flexibility of ideology has no significant impact ($p_I=1$ & $T_{\text{max}}=7$). Interestingly if parties do not stick to their ideology when they write their programs in order to optimize the probability to win the election, and the parties do not adapt to changing preferences, there is an increase of NGOs but the participation in governmental programs remain on the same low level ($p_I=0$ & $T_{\text{max}}=7$). The reason for this is the default value of γ which leads elected officials not to implement what they promised, and do not stick to their ideology either.

Given p_I equal to 0, thus no adaptation of ideology of parties, we explore the impact of transaction costs. Participation in NGO programs is not free. Tax is already paid for the governmental programs, and extra resources are required for NGO programs. For 2 levels of p_{influx} we analyzed the effects. As expected, higher transaction costs leads to more governmental program participation and less NGO creation. Extreme dissatisfaction with government service providers still leads to some NGO creation with high transaction costs. Again, we see some of these general trends in the land use policy arena, where many NGO programs are created, but a fairly small portion of the population participates.

When we vary the threshold at which a voter becomes dissatisfied enough to become a political entrepreneur, we see a gradual decline of agents participating in governmental programs when the threshold of dissatisfaction is lower (Figure 5). At lower threshold there is also a larger number and variety of NGO programs (Figure 6).

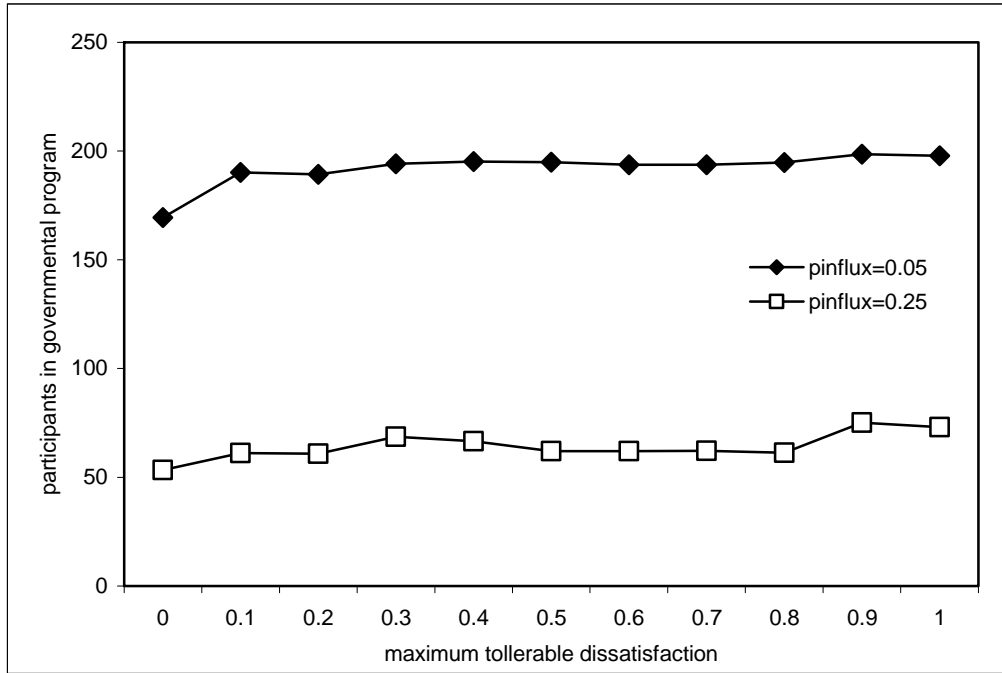


Figure 7.4. Number of Voters Government Programs with Varying Dissatisfaction Thresholds
Note: This is after 10 election rounds for different levels of transaction costs c as an average of 100 runs, for two levels of p_{influx} .

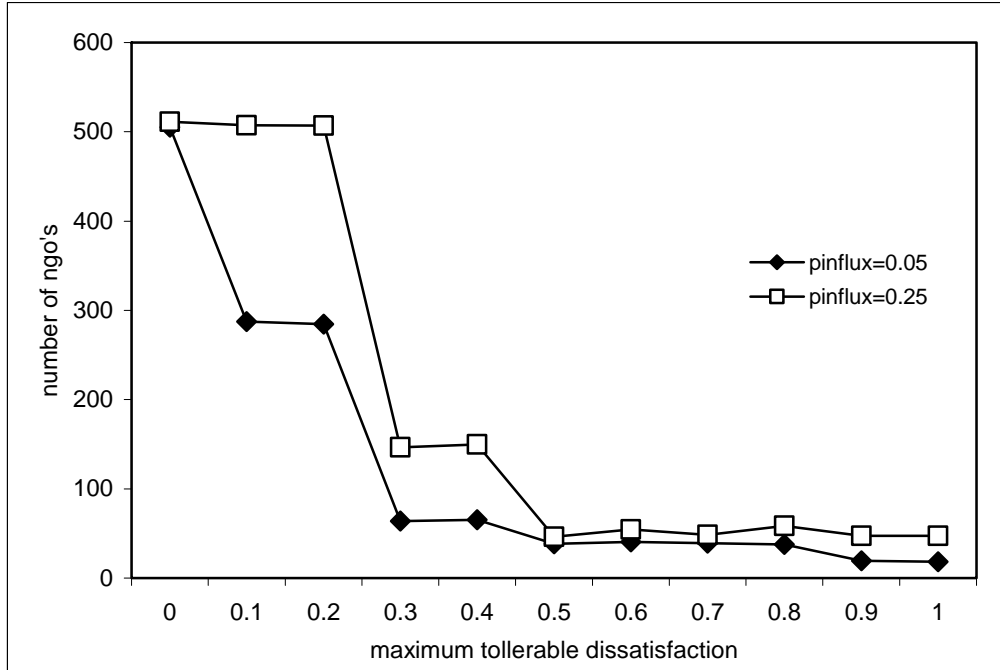


Figure 7.5. Number of NGOs with Varying Dissatisfaction Thresholds

Note: This is after 10 election rounds for different levels of transaction costs c as an average of 100 runs, for two levels of p_{influx} .

The priorities set by the elected officials have less influence on citizen participation than the priorities set by the bureaucrats, as citizens are making participation decisions based on the implemented programs. We analyzed the effect of combinations of γ and γ_b when p_{influx} is 0.25 and ideologies of parties do not change and as Figure 7.6 shows, when bureaucrats put more weight on satisfying the preferences of the officials, the level of participation in governmental programs drop. This is especially the case when elected officials focus on implementing their ideologies, instead of maximizing the probability to be reelected.

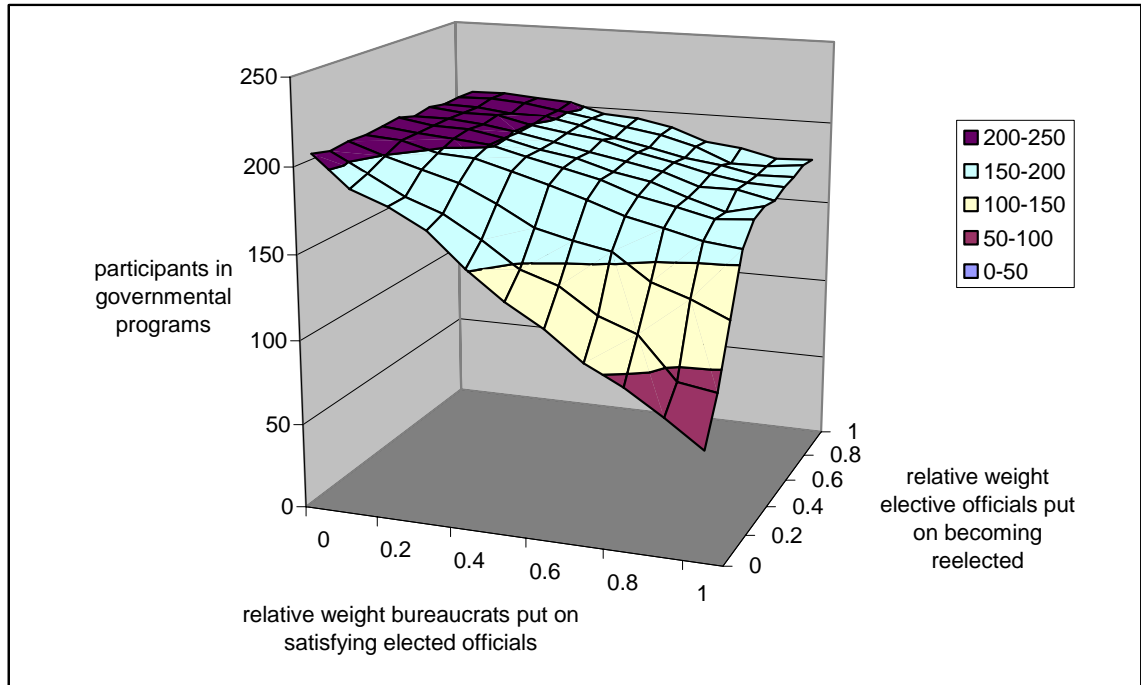


Figure 7.6. Government Participation in Relation to Government Sensitivity to Citizen Demands
 Note: this is after 10 election rounds for different levels of γ , the weight elected officials put on becoming reelected versus matching the preferences of the citizens.

A puzzling result is that the number of NGO programs created is low when elected officials focus on their ideologies and bureaucrats satisfy the officials (Figure 7.7). This may occur because the portion of the population with preferences similar to the elected officials is well served by the static regime, and with p_{influx} equal to 0.25, the system is only moderately dynamic. In this type of situation there is no need for conservative NGO, since they are served by the governmental programs.

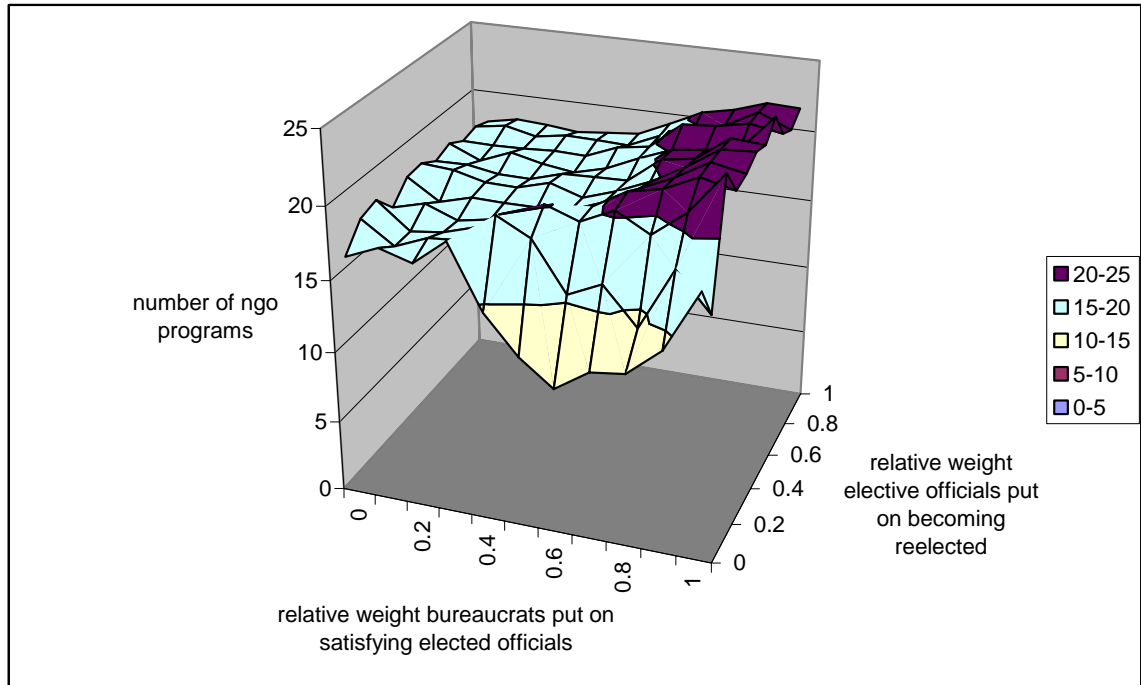


Figure 7.7. Number of NGOs in Relation to Government Sensitivity
 Note this is after 10 election rounds for different levels of γ , the weight elected officials put on becoming reelected versus matching the preferences of the citizens.

Conclusions

The computational experiments show that the number of NGOs and variety of NGOs is the highest at a moderate level of change of preferences of the citizens, especially when parties change their ideologies, yet are unable to fill the gap on the left and right of policy preference spectrum. We find that NGO creation initially occurs by the newcomers who hold minority preferences, but as this minority becomes a majority NGO creation increases by the residents with more traditional preferences. Within an urbanizing landscape, this type of policy preference change has been described by Rudel (1989) who argues that rural residents may not be prepared for the difference in land use policy views, as exurbanites move into their community. As demonstrated in Figure 8, this does not occur under a static government regime with low preference change.

Even with extremely high transaction costs, there is still some NGO creation due to the dissatisfaction of citizens with low to moderate dissatisfaction tolerance and extreme preferences. These citizens face some challenge in creating and maintaining NGOs, as it may be difficult to find similar voter types to participate. Thus, citizens with extreme policy preferences will be more likely to create a NGO option. In the land use policy arena, there are many organizations catering to the needs of citizens with unique views on land management, although as discussed in Chapter 6, it is difficult to create institutions for cooperative management. As Janssen and I found in the general model, with high transaction costs, which are common for cooperative management, NGO institutions will be created, but they will frequently fail with limited citizen demand.

In our general experiments, we find similar patterns of NGO creation under mobile and highly mobile citizen conditions. In a highly mobile jurisdiction, the elected officials are less able to adapt, which leads to an increase in NGO creation. Even with a moderately mobile population, it is difficult for both NGOs and government to adapt leading to high turnover in programs and an extremely dynamic policy arena. The effects of an increase in mobility on NGO creation are strengthened when citizens are easily dissatisfied. If citizens have low dissatisfaction tolerance, at a level of 0.1, NGO creation is almost double with a highly mobile citizenry versus the mobile condition, approximately 525 programs versus 275 programs respectively. Thus the relative mobility of within a jurisdiction can have a large impact on the NGO creation. This may be important if there is a one time influx of citizens with a particular preference into the system, which leads to the NGO creation. Since these are a relatively small portion of the constituency there is limited incentive for party adaptation.

Empirical work may test the impact of migration on NGO creation, especially because migration may indicate fewer resources and greater transaction costs for NGO creation. Given a constant resource base, we expect that a jurisdiction experiencing great growth in minority populations will produce more NGOs. Even with a highly responsive government, it is difficult for bureaucrats and elected officials to respond dynamically changing citizen preferences.

Furthermore, the creation of private service providers often has a spatial component, such as gated communities. Future work may examine how the spatial distribution of citizen preferences may impact NGO creation for specific districts within jurisdictions. We expect to find neighborhood effects due to clustering of preferences, although this may be mitigated in a highly mobile society.

Our model has illustrated how changes in mobility may be linked to NGO creation when incoming agents have different policy preferences. Furthermore we have illustrated that a moderately adaptive government is unable to address changing preferences in a highly mobile society, but NGOs also struggle under these conditions. We find the greatest quantity and diversity of NGOs in a society with some government adaptation and moderate influx of citizens. We investigated of the interrelationships between elected officials responsiveness, bureaucratic implementation, changing citizen preferences, and NGO service provision. This preliminary investigation indicates that the private provision exit option is important in the investigation of local policy formation and implementation.

As mentioned earlier, this experiment was designed to evaluate the general local political economy, not the land use policy arena. Even with this consideration the general

model offers some insights into the creation of alternative institutions. Furthermore, we find that citizens may be satisfied with government options if bureaucrats and elected officials are relatively sensitive to citizen preferences. Thus, an explosion of alternative land use institutions would be expected with a fairly insensitive government and moderate to high levels of citizen preference change. On the other hand, even with a responsive government, citizen preference change will drive the demand for alternatives.

In this chapter, we have found that citizen mobility is an important driver of private institutional provision. This may partially explain the real world cases of demand for private institutions discussed in Chapter 6. Many of these institutions were created where there were changing preferences due to exurbanization. Furthermore, bureaucratic and official insensitivity may also drive citizens to seek private options.

Chapter 8: Land Use Institutions: Conclusions

By Abigail M. York

Throughout much of its history zoning has been criticized as ineffective, especially by visionary planners, and unjust, mostly by property rights advocates. Few individuals have argued that zoning is an effective tool for growth management, environmental protection, or historic preservation, although zoning is the most widely used land use control. Much of the attention to these issues has been focused on the comprehensive planning process from the time of Babcock's investigation of *The Zoning Game*, although some scholars focus on institutional impacts (for example Feiock 1994; Platt 1996). In this study, I have explored the ability of communities to control growth through zoning and alternative institutions. I have found mixed evidence regarding zoning's impact on land use change. Some of the previous criticism of zoning seems justified, although there are important ways that zoning could be improved to mitigate negative effects in the urbanizing landscape. Some of these policy recommendations will be discussed below.

In this final chapter, I will first address the challenge and the need to use a multilevel analysis to evaluate a complex local policy, such as land use institutions. Then I sum up the findings with regard to the questions that I laid out in Chapter 1: 1) Does zoning protect forest and farmland? 2) Does zoning lead to fragmentation of land cover? When do zoning rules match citizen preferences? 3) When do we expect zoning compliance? 4) What are the alternatives to zoning? As I sum up findings, I will highlight the conclusions, as well as the strengths and weaknesses of each empirical

approach. This dissertation is a part of a larger research agenda, so I also describe for upcoming or ongoing research projects that stem from my dissertation work.

8.1 Multiple Methods

As can be seen in the breadth of questions that this study addresses, there is no single method that can effectively address these issues and aid in our understanding of land use institutions. Part of the importance of this study is simply the use of multi-level analysis and use of multiple methods to understand zoning and alternative land use institutions. Most studies of zoning have evaluated policy adoption in communities, not the impact of this adoption. As mentioned earlier, previous studies of zoning have included case studies of individual jurisdictions (Babcock 1966; Babcock and Siemon 1985; Rudel 1989), historical analyses of land use regulation (Diamond and Noonan 1996; Platt 1996), analyses of zoning rule implementation (Fleischmann and Pierannunzi 1990; Feiock 1994; Thorson 1997; Ellison 2001), and studies of zoning's impact on local economies (Harrison 1977; Fischel 1985; Hanushek and Quigley 1990; Thorson 1997; Fleming 1999). Some recent work has evaluated the relationships between zoning and land cover fragmentation (Brabec and Smith 2002) or land cover change (Kline and Alig 1999; Hsieh, Irwin et al., 2000). These studies provide valuable information about the impact of zoning on economic development in the theoretical or in a particular study area, the context of rule changes within a comprehensive plan, or describe classic battles between officials and citizens, but these studies do not attempt to understand broadly the impact of zoning across a region, fragmentation at the parcel level, zoning compliance, and alternatives to zoning.

Furthermore, much of the work has focused on “progressive” states such as Florida, Oregon, and Vermont. These progressive statewide efforts have been hailed as means to reduce uncontrolled development (Platt 1996), yet few studies have evaluated development and land cover change in states with variation in implementation of traditional land use controls. This study has provided analysis of zoning in a state, Indiana, that has great variation in land use controls across the southern region with many counties that do not employ any countywide zoning ordinances (Worgan, Harbourn et al. 2001). Counties with zoning primarily adopt traditional separation of uses zoning rules with a few Smart Growth principles included in comprehensive plans. In addition, many of these plans are out of date and have not been updated since the 1970s. The empirical portions of this dissertation ground my general study of the impact of zoning and alternative land use institutions.

The theoretical analyses enable us to better understand zoning compliance, as much work focuses on rule creation not rule implementation. The use of the game theory strengthened our understanding of the weaknesses of zoning without effective citizen monitoring and predictable fines for violations. Within the local political economy model, we also began to understand how alternative institutions may be generated by unmet demand due to government insensitivity or dynamics in citizen preference distributions. These theoretical analyses lay the ground for further empirical work and also further our understanding of complicated issues that may be difficult to comprehend with empirical studies. Using the general political economy model, Janssen and I were able to experiment with differing rates of citizen preference change and bureaucratic and elected official sensitivity. The union of theoretical and empirical approaches grounded

my work in the real world, while allowing me to evaluate conditions that are difficult to observe or nonexistent in the real world.

Besides using both theoretical and empirical approaches, I also evaluated land use institutions at a variety of scales. I looked at the jurisdiction, county, and parcel levels. As described earlier, many prior studies look only at one scale and so are unable to assess the broad impact of a particular institution. Zoning was evaluated at the county and parcel levels, as well as the theoretical jurisdiction in the local political economy. In my discussion of alternative institutions, I talked about cooperative management at a sub-county or sub-municipal level, but with more than one parcel. By using several different scales, I am able to assess some of the impacts of zoning at the jurisdiction wide scale. Specifically, are there differences in land cover change in counties with or without zoning? This analysis is important because zoning is adopted at the county or municipal level. While most land use decisions are made at the individual parcel level, so this analysis of fragmentation and zoning compliance aids in our understanding of zoning on the ground. Since zoning does not adequately address all citizens' demands, the local political economy model in Chapter 7 highlights when we expect NGO options to be created. My discussion of cooperative management in Chapter 6 illustrates the options available to landowner that seek to cooperatively manage land at the sub-county level.

Investigating local institutions at several different scales is important, but it is also important to understand the effects of these institutions over time. Three chapters addressed time effects in very different ways. First, the land cover change analysis evaluated the impacts of zoning from 1940 to 2000 on land cover change from 1970 to 2000. The study of zoning compliance investigated the reporting and violating neighbor

game over time, although one suspects that this theoretical time horizon is typically shorter than sixty or thirty years. Finally, the local political economy model investigated institution adoption, adaptation, and implementation over a ten election period in both the government and nongovernment sectors. These different analyses allow us to understand some of the dynamics of institutional change and institutional impacts on a landscape.

We must try to understand enforcement's relationship to land cover change in order to assess the impact of zoning. These multiple methods at multiple scales used in allowed investigation of zoning from macrolevel regional change at the county level to microbehavior between neighboring landowners. The combination of approaches helps us understand the complicated relationships between bureaucracy, citizenry, and politicians at the local level within the land use control arena.

We began this study by evaluating the institution of zoning and exploring the goods that are producing through zoning adoption and implementation. We learned that the zoning policy arena is complicated, as community types may influence how and if zoning is adopted. After zoning is adopted communities may be more or less inclined to monitor landowners' behavior. Thus, enacted zoning may have little impact on an urbanizing landscape if the *de facto* rules do not match the *de jure*. As discussed in Chapter 2, the ability of communities to achieve plan goals is difficult as actors most navigate the complex action arena. Once a plan is in place the limited enforcement of the plan and indiscriminate granting of variances reduces the effectiveness of the plan to achieve its goals. Local land use institutions' complicated nature, especially in the dynamic urbanizing landscape, required the use of multiple methods. In the next section,

I evaluate findings for several key questions relating to the effectiveness of these institutions.

8.2 Key Issues Addressed in Dissertation

Multiple methods and multiple scales were used to investigate several key issues regarding land use institutions in an urbanizing environment. I addressed whether zoning protects forestland and farmland. I investigated whether zoning contributes to or prevents fragmentation of forestland. The next issue addressed was the relationship of zoning to the larger community. Since zoning is typically enforced through citizen complaints, another aspect of this dissertation addressed when citizens will report their violating neighbors and when violators will start to comply. Finally, the dissertation investigated alternatives to zoning or institutions that could be used in conjunction with zoning to protect forestland.

8.2.1 Does zoning protect forest and farmland?

As I discussed in previous chapters, zoning has been routinely criticized for being ineffective at protecting natural resources, or even identified as causing some deforestation and urbanization. In Chapter 3, we evaluated zoning across a region, southern Indiana, over a thirty year time period with zoning policy lag variables included for a total of sixty years. The econometric analysis yielded some interesting and possibly disturbing results. The positive, although insignificant, relationship between urban to agricultural land use and zoning in our models indicates that counties may not adopt zoning until there is a relatively high level of urban development. As discussed earlier, this may be an indication of a threshold effect similar to that found in New England communities (Rudel, 1989).

The inclusion of historic zoning policy variables, zoning 15 or 30 years prior, mitigated some of the positive relationship, although was insignificant. Perhaps zoning has a greater impact on land use change over a long time horizon. On the other hand perhaps communities that were early adopters of zoning controls are experiencing a decline in the rate of growth because these are already built up. We need to better understand the complex relationship between zoning and land use. Our study indicates that there is a significant relationship between land use and zoning, although the interpretation of this relationship is not straightforward. Zoning is not the cause of the level of urbanization, but there are some indications that urbanization may also impact zoning adoption. Our results are not inconsistent with the theorists who argue that zoning may accelerate urbanization and sprawl, through ordinances such as minimum lot requirements, although the insignificant and mixed directional impact illustrates that zoning is not a clear driver of open space loss or protection in an urbanizing landscape.

Our findings illustrate a need for further research on the relationship between land use and policymaking because of the apparent interactions between land use changes and local policymaking. The purpose of this study was to assess the broad impacts of zoning instead of focusing on isolated impacts within particular jurisdictions. Our results at the regional scale do not refute the claim that zoning, through policies like minimum lot requirements, accelerates peri-urban development, but neither do we find conclusive evidence that zoning causes sprawl.

There are two sources of weakness for this preliminary analysis. First, the area of the analysis was the county, although some of the counties did have other zoning jurisdictions, usually within the urban areas within the counties. It would have been

useful to somehow merge the zoning and planning for the county and the city. Since we used zoning as a dummy variable to generally address the relationship between urbanization and zoning, in counties and cities with zoning this was not necessarily a problem. In counties, without zoning and cities with zoning this county level analysis is of greater concern. Specifically, some cities have zoning control outside the city limits into the unzoned county region. The importance of our study is addressing whether we can see any difference between unzoned and zoned counties because leapfrog development into unzoned areas has been an issue raised by Carruthers (2003). Therefore, I proceeded without the city zoning data because the focus was on per-urban areas. Using the county dummy variable captured whether there was zoning policy in the rural regions.

The second weakness is the use of a dummy variable for zoning. Zoning is a complicated policy, as I discussed in several chapters, so it was difficult to determine how to quantify zoning. Furthermore, zoning in the books and on-the-ground are often different. Thus, the dummy variable enables a preliminary investigation of the relationship between the policy and its impact.

In future, research the endogenous relationship between zoning adoption and land use should be considered as it will address whether there is a threshold effect where developed communities are more likely to adopt land use policy. Many communities will not adopt zoning until there is a significant amount of land that has urbanized. A system of equations approach should include zoning, percent developed land, and housing starts and address the simultaneous relationship between zoning, economic development, and land cover change. The econometric research may also be extended to the entire state of

Indiana, which may allow further investigation into the relationship between agricultural use and zoning. It may be possible to represent the variation in implementation and enforcement via a zoning index, which may further our understanding of the relationship between zoning and land use. Furthermore, a study of areas employing more modern zoning laws, such as use of impact fees and urban growth boundaries, may uncover a different impact on land use decision-making.

Overall our regional analysis does provide some interesting issues for future research. Few people have attempted to quantify zoning across a region, so starting with a dummy variable is appropriate. Future projects will incorporate more complicated zoning measures. In summary we found that zoning does not necessarily protect farm and forestland when measured at the county level.

8.2.2 Zoning and Fragmentation at the Parcel Level

In Chapter 4, we found that zoning played a greater role in fragmentation in the urbanizing area of Monroe County, while was of limited importance in the more remote areas of the county. There was a statistical link between zoning and parcel level fragmentation. In our fringe region of northwestern Monroe County there is competition between development near the town of Ellettsville's infrastructure and agricultural land use because the flat terrain is ideal for both buildings and agriculture. The zoning was of greater importance in this area possibly because of the direct competition between agriculture and development. Whereas in other forested areas of the city the slope is great, so building is relatively difficult. Therefore, policy has a loss of importance because the natural conditions, hilly land with poor soils, limit the viability of potential land uses. Our results indicate that zoning policies have a greater impact on landscape

and forest fragmentation in some areas of the county than other areas, i.e., in those areas where both the cost of development due to topography is lowest *and* development pressures (in terms of city access) are highest, as in areas near Ellettsville.

Many planners have advocated the consolidation of planning power at the state level. It may be effective to establish multiple layers of regulation that deal with large ecological or topographic features stretching across political boundaries. However, this study indicates that fine-scale, parcel level characteristics may also play an important role in the success of zoning policy. Perhaps, a polycentric political structure that incorporates several levels including federal, state, and local policymakers may solve more of the problems associated with urbanization than approaches that focus on any one particular level exclusively.

Overall in Chapter 4, we found that zoning's impact on fragmentation is mitigated by biogeophysical factors. In areas of high development pressure, there is great potential for zoning to regulate growth, although in the case of Monroe County we find that lax zoning can lead to fragmentation in a high pressure area. There are complicated relationships between parcel characteristics, zoning, and landscape fragmentation indicating a need for policymakers to be especially careful in evaluating the interrelationships among these factors when making an assessment of the effectiveness of planning and zoning policies. Our initial study illustrates the complexity in evaluating the impact of zoning policy and demonstrates the need for further work examining other complicating factors such as larger regional effects from major metropolitan regions, and the effectiveness of implementing policies over larger biogeophysical areas.

8.2.3 When do we expect zoning compliance?

The ability of zoning to influence landowner behavior was explored in Chapter 5. Specifically we evaluated how greater access to zoning rules could increase reporting of zoning violations. Under certain conditions, repeated games, it appeared that more information was of little importance if a zoning inspector was unwilling to monitor and fine after citizen complaints. While, a responsive inspector meant that information would lead to an increase in complaints and compliance.

As was shown in the simple games of Chapter 5, one of the most important factors is the fine levied on the violator. Some jurisdictions increase fines for repeat offenders (Ellickson and Been 2000), which may stop the extended game, increasing the marginal cost for each violation. As I discussed, another important factor is the cost of reporting for the neighbor. With difficulty in contacting inspectors and inducing an inspector to check out the violator, we may expect that violation will continue. In the repeated game, we expect that a neighbor who has faced a high reporting cost because of a struggle may look the other way and not report if the inspector does nothing after the first report. On the other hand, we expect that neighbors who are well connected with local government will report often, because of the low cost and high probability of response from the inspector. With the addition of online GIS technology, citizens may more easily determine whether there is a violation. Furthermore, if a community has an online compliant system, similar to Reno, Nevada, we expect that reports will increase because of a decrease in the reporting costs for neighbors.

This study investigates a common problem in the zoning arena, as well as other types of local enforcement, how do you effectively enforce a rule when official inspectors

have limited resources and are unable to canvas an entire jurisdiction? As discussed earlier, violations can be difficult to spot from afar and certain types of violations may only be visible during a short period of time. Therefore, like many police measures, zoning relies on citizen complaints to be enforced. One impetus for zoning within a community is to reduce nuisance violations, which impose costs on neighbors and the community. The neighbor games allow us to better understand the impact of zoning on the ground, as the institution is only as good as its enforcement. The games indicate that neighbor reporting is an important element in local land use enforcement, and neighbors can be effective monitors, if supported by fines and fairly responsive inspectors.

Neighbors also need to be aware of the zoning ordinances and zones that surround them to be effective monitors. Recently many communities have created electronic copies of zoning ordinances that are available online. I anticipate that access to ordinances through the convenience of the internet may increase the numbers of citizen reports. Furthermore, some communities have created parcel level zoning maps that are available online. These maps enable neighbors to determine whether a possible violation is actually an allowable use. Thus, we may see some changes in the number of reports and accuracy of citizen reports with the increased access to zoning ordinance information.

8.2.4 What are the alternatives to zoning?

Throughout this dissertation I discussed how zoning is limited because it takes away property rights, but may not be able to effectively promote land management. Because of zoning, landowners are not allowed to do particular activities on their land, such as run a home business, but there are limited means to induce landowners to do

management activities. Of notable exception are some of the home repair guidelines and lawn maintenance requirements in many cities and towns. With regard to large land areas there are typically few requirements for landowners. Many landowners are looking for alternatives to zoning in order to promote forest management and preservation of openspace. In Chapter 6, we explored these alternatives: conservation easements, conservancy districts, property owners' associations, and contracts.

One difficulty of using zoning for cooperative management is the relatively large size of the jurisdiction and the public process, which may make it difficult for individuals seeking fairly restrictive preservation oriented rules. The legal mechanisms discussed in Chapter 6 could be used by landowners to promote various aspects of cooperative management. These could be coupled with zoning, which directs development away from the cooperatively managed land. Chapter 6 could be strengthened by evaluated with case studies of groups using some of these legal institutions for ecosystem management. Many of these institutions have not been used for these purposes, as far as we know, which is why landowners were contacting the Indiana Department of Natural Resources to learn about new mechanisms for cooperative management. Thus, as groups adopt some of these mechanisms for cooperative management, we may be able to assess effectiveness.

Cooperative management is an emerging objective throughout the United States, especially with respect to preserving large areas of openspace and forestland. Zoning can be used to promote this goal, but it may difficult to achieve preservation or active management solely through the local government. As demonstrated in Chapter 7,

sometimes citizens with minority policy preferences may opt for private provision or regulation when the local government is unresponsive to their preferences.

The ability of citizens to produce these alternatives is related both to the government provision of regulation, party adaptation, and elected official and bureaucratic responsiveness. The computer experiments in Chapter 7 showed that the number of NGOs and variety of NGOs is the highest at a moderate level of change of preferences of the citizens, especially when parties change their ideologies, yet are unable to fill the gap on the left and right of policy preference spectrum. NGO creation initially occurs by the newcomers who hold minority preferences, but as this minority becomes a majority NGO creation increases by the residents with more traditional preferences. Even with extremely high transaction costs, there is still some NGO creation due to the dissatisfaction of citizens with low to moderate dissatisfaction tolerance and extreme preferences. These citizens face some challenge in creating and maintaining NGOs, as it may be difficult to find similar voter types to participate.

There are similar patterns of NGO creation under mobile and highly mobile citizen conditions. In a highly mobile jurisdiction, the elected officials are less able to adapt, which leads to an increase in NGO creation. The relative mobility of within a jurisdiction can have a large impact on the NGO creation. This may be important if there is a one time influx of citizens with a particular preference into the system, such as in an urbanizing area, which leads to the NGO creation. This influx may represent a relatively small portion of the constituency, so there is limited incentive for party adaptation. Our model has illustrated how changes in mobility may be linked to NGO creation when incoming agents have different policy preferences. Furthermore a moderately adaptive

government is unable to address changing preferences in a highly mobile society, but NGOs also struggle under these conditions. The greatest quantity and diversity of NGOs occurs in a local political economy with some government adaptation and moderate influx of citizens. This preliminary investigation indicates that the private provision exit option is important in the investigation of local policy formation and implementation. In this chapter, we have found that citizen mobility is an important driver of private institutional provision. This may partially explain the real world cases of demand for private institutions discussed in Chapter 6.

Future work may balance the exit opportunity and cost to exit versus initiating and participating in private institutions serving the minority preference population enabling us to explore Tiebout's exit option. In the future experiments, we would include transaction costs for moving that are similar to those for creating NGO's. Furthermore, the creation of private service providers often has a spatial component, such as gated communities. Future work, may examine how the spatial distribution of citizen preferences may impact NGO creation for specific districts within jurisdictions where there may be neighborhood effects due to clustering of preferences, although this may be mitigated in a highly mobile society.

Empirical work may test the impact of migration on NGO creation, especially because migration may indicate fewer resources and greater transaction costs for NGO creation. Given a constant resource base, we expect that a jurisdiction experiencing great growth in minority populations will produce more NGOs. Since this is a computer model, it will be useful to ascertain the real world significance of our results. Both Chapter 6 and 7, illustrate the options available for cooperative management, or for

alternative institutions in a local political economy. In the following section, I will explore how some of my findings relate to current Southern Indiana land use policymaking.

8.3 Relevant Findings for Southern Indiana Policymakers

From my research, there are some findings that could be useful for policymakers in the southern Indiana region. Few southern Indiana counties included implementation and assessment goals and standards in their comprehensive plans, as I discussed in Chapter 2. Only one county included quantifiable measures for assessment of plan progress. Similarly, only one county included an implementation schedule, although the schedule focused primarily on infrastructure. It is difficult for the citizenry, as well as policymakers, to assess the effectiveness of a plan with no quantifiable measures in place.

Many southern Indiana counties were concerned with balancing economic development and protecting their communities and natural resources. I found that the majority of plans in Indiana included some Smart Growth principles in their plans, although the counties did not focus on the implementation and funding for these initiatives. The majority of counties were concerned about the protection of their rural and agricultural resources, but wanted economic development. Planning potentially could help to aim development toward resource poor areas, while attempting to protect valued openspace areas. Since communities were not given any benchmarks for successful plan implementation it is difficult to assess how these communities are doing.

Chapter 3 provides some disconcerting results for southern Indiana planners, namely that zoning may drive urbanization. This conclusion is not new and has been explored theoretically in many studies. The main driver may relate to minimum lot size

requirements. Thus communities may want to rethink inclusion of large minimums especially in the urban-rural fringe. In order to better understand whether minimum lot size requirements are driving the urbanization process, a study focusing on this type of rule should be conducted. Communities should think about zoning rules, such as minimum lot size requirements, if protection of forest and farmland is a priority, although it is unclear from these results how a community should address this issue. As discussed in Chapter 2, most communities are not focused on coordinating development and protecting openspace, or other Smart Growth principles. Adoption of some of these principles may reduce the effect if the positive relationship between zoning and conversion of farmland to urban uses.

Results from Chapter 4 indicate zoning played an important role in fragmentation along the urban-rural fringe in Monroe County. In our study, this was a negative relationship, but communities could improve this through recognition of the importance of zoning in this particular area. Thus, a community seeking to address habitat fragmentation should look first at the urbanizing area near the urban-rural fringe, as remote properties are under less strain and risk of fragmentation. On the other hand, some communities may recognize that these peri-urban properties will likely be subdivided and fragmented in the near future, so focus on the more remote properties to provide longer term protection of contiguous forestland.

As I mentioned throughout the dissertation, institutions are weakened by limited enforcement. GIS may aid citizens in their role as monitors of zoning compliance. Again this may reinforce disparate monitoring in more affluent areas through the digital divide. On the other hand as more individuals gain access to online information, some

less affluent communities may be better able to get information quickly in high risk areas. Thus communities may seek to improve compliance by offering searchable databases to citizens. There is one municipal example of this in southern Indiana, in Bloomington, where citizens are able to search based on address and name. If counties developed similar databases, citizens would have more accurate information about the zoning laws restricting land use on their property and on parcels throughout the county. Communities must realize that this may generate too much call volume with complaints. On the other hand, in fairly inaccessible areas, such as in the rural portions of the county, this may enable better and more efficient enforcement of zoning. Within southern Indiana, there is limited online information, so small changes such as including zoning ordinances online could lead to big improvements. As communities invest in GIS technology to keep track of parcel information for tax collection and zoning, the community may want to consider putting this information online. As citizens gain greater access to the internet, online searchable zoning maps will enable more accurate citizen monitoring, which may reduce violations, especially if coupled with increasing fines for repeat offenders.

Alternatives to zoning may be the best option for protection of particular resources within southern Indiana, such as areas of openspace. Communities may support the creation of these alternatives by making it easier for citizens to learn about alternatives such as conservancy districts, property owners' associations, land trusts, and contracts. If communities provide information to landowners about alternative institutions there may be an improvement in the protection of community resources, as well as less of burden placed on zoning. Furthermore these alternatives may satisfy the demands of long time rural residents that are increasingly a minority in urbanizing areas,

or the new exurbanites that a minority in peri-urban areas. Communities may improve their land use institutions by updating out-of-date plans, rethinking zoning rules, making zoning information accessible, and providing information about alternative institutions. As discussed earlier Indiana is a great case to investigate because of the great diversity in policy, economic conditions, and urbanization. Insight from the southern Indiana case can be used generally for many areas, although some of the specific conditions like the impact of relatively steep slopes may not apply to other states. This case is also interesting because it differs greatly from most of the studies on zoning, which have focused on progressive policies in areas such as: Florida, Vermont, and Oregon.

8.4 Directions for the Future

This dissertation is the beginning of a larger research agenda investigating local land use institutions. There are four major projects at different stages of implementation that I have started as a result of dissertation findings. The first project extends the econometric analysis in Chapter 3 by creating a simultaneous equation model of zoning policy adoption, urban land cover, and median income. The second project brings the games from Chapter 5 into the experimental lab in order to test some of our conclusions regarding citizen reporting, zoning enforcement, and zoning compliance. The third project brings the local political economy from Chapter 7 into a theoretical spatially explicit landscape. We are adding space, an essential ingredient in land use policy, as well as many other local policies. Finally, the last project brings Chapter 6 into the real world. We share insights from our institutional analysis with landowners, bureaucrats, and officials in order to improve policy, as well as improve our analysis.

First, I will address the simultaneity issue raised in Chapter 3 by using zoning policy adoption of what Feiock terms second level policies, development impact fees. These policies more directly indicate a counties commitment to growth management, or its desire to grow at whatever cost. The other equations in the system include percentage urban land cover as a dependent variable and median income. This study furthers the tradition of Peterson, in that urbanization is expected in areas that are poor with limited growth controls. I control for other attractors to communities such as recreational amenities and distance to other urban areas. Thus I model the growth process and growth control in a simultaneous manner. The 40 county study area will not be large enough to effectively model this process with an expected number of dependent and independent variables exceeding the number of counties over the time period. The small study area may be supplemented with counties in northern Indiana and Ohio, where a similar research project is underway. The challenge in this process is that there are no archives of these documents, so a panel analysis over the thirty years probably is unrealistic. Thus, the study will either be done at one or two time points within the past ten years.

Second, another ongoing research project is in citizen monitoring of neighbor behavior. I am planning to run economic experiments over an abstract computer landscape. These will build on spatial experiments currently being run that evaluate land management behavior with positive externalities from neighbors. In our experiments, we plan to build upon the games in Chapter 5. In the different experiment conditions, landowners will be given varying information gathering costs, regulation information, and reporting costs.

The third project moves the local political economy into an abstract computer jurisdiction. The jurisdiction will allow us to evaluate how heterogeneous preferences across space may increase or decrease the creation of “gated communities” or other alternative land use institutions. This project investigates movement and political activity within a community in a similar vein to Tiebout, but allowing the citizen choice to be between public and private institutional options instead of different jurisdictions. Given the urbanizing landscapes throughout within southern Indiana and throughout the United States, it will be interesting to generally determine when location oriented NGO institutions such as property owners’ associations and land trusts will be created given changing demand for openspace and natural amenities.

The final research project will assess landowners’ adoption of alternative institutions. I co-chaired a conference, “Forestland Conservation: An Indiana Portfolio,” which brought information about these alternative institutions to landowners throughout Indiana, as well as to other academics, bureaucrats, and NGO officials. Currently, I am working with scholars at Purdue, including Drs. William Hoover and Shorna Broussard on this alternative institution project. We plan to focus on groups that are considering alternative institutions, and which groups have experience with these alternatives.

8.5 Conclusion

This study focused on land use institutions in an urbanizing environment. There are several important conclusions from the study. First, zoning may be driving some conversion of land to urban uses, although this may be due to the types of zoning rules that are adopted. Second, zoning could be used more effectively to reduce forest fragmentation or at least not promote fragmentation. Third, adoption of online GIS

technology could improve zoning enforcement through a reduction in citizen monitoring costs. Fourth, there are viable alternatives to zoning for openspace preservation and cooperative management. Finally, government insensitivity and changing citizen preferences may be driving this demand for alternative institutions.

Another important aspect of this study comes through the union of approaches to investigate local land use institutions. By evaluating zoning at multiple scales and with multiple methods, we begin to understand the strengths and weaknesses of zoning as currently implemented. The union of different techniques, theoretical and empirical, and evaluation over time and across space provides insights that were lacking in studies that only focused on a single study site or a single point in time

Furthermore, my emphasis on the institutions as implemented and enforced, instead of just the rules on the books, differs from many zoning studies that focus primarily on planning ideals. As I discussed in “Directions for the Future,” I need to better address the actual zoning rules, such as the impact fees assessed. This dissertation represents the beginning of an investigation of the real zoning game, not just the paper game.

Overall, I have uncovered more puzzles that need to be addressed than I have answered with this dissertation. The most important contribution of this dissertation is the understanding that zoning and alternative institutions should be evaluated from multiple angles. Perhaps most importantly we need to understand individual decisionmaking under the institutions, as well as the dynamics in the local political economy. Zoning is not the only institution that can control growth in an urbanizing environment, especially given some of the negative findings in southern Indiana. There

is room for improvement in zoning implementation and enforcement, but communities should also look to alternatives to zoning for protection of openspace and promotion of cooperative management. Overall local land use institutions may be hurtful or helpful in the urbanizing environment, but their impact is dependent on implementation and enforcement, which may be lacking in southern Indiana. In the theoretical studies, it appears that some of this breakdown in government institutions could be due to changing citizen preferences, similar to preference changes in urbanizing landscapes. There are opportunities for use of institutions in urbanizing landscapes to protect community resources, but communities need to be more conscious about their decisions regarding institution creation and implementation in order to control the urbanizing process and reduce unwanted effects.

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PEER REVIEWED PUBLICATIONS

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“Jobs, Houses, and Trees: Changing Regional Structure, Local Land-Use Patterns and Forest Cover in Southern Indiana.” with Darla K. Munroe. 2003. *Growth and Change*. 34(3): 299-320.

“Diversity of Incentives for Private Forest Landowners: An Assessment of Programs in Indiana, USA.” with Marco Janssen, and Laura Carlson. Forthcoming. *Land Use Policy*.

“Is Land Use Policy and Landscape Fragmentation in an Urbanizing Region: Assessing the Impact of Zoning.” with Darla K. Munroe and Cynthia Croissant. In Press. *Applied Geography*.

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“Zoning’s Impact on Farms, Forests, and Strip Malls: A Southern Indiana Investigation.” with Darla K. Munroe. Under Review. *Land Use Policy*.

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